Louisiana Department of Natural Resources

Barrier Island Plan

DNR Contract No. 25081-95-02

Phase 1 - Step F

Inventory and Assessment of Existing Economic and Resource Conditions Final Report

July 31, 1997

T. BAKER SMITH & SON, INC.

Established 1913

ENGINEERING • SURVEYING • ENVIRONMENTAL

PROFESSIONAL SERVICES

Barrier Island Plan

DNR Contract No. 25081-95-02

Phase 1 - Step F

Inventory and Assessment of Existing Economic and Resource Conditions

Final Report

February 17, 1997

T. Baker Smith & Son, Inc.

Houma, La.

PROJECT OVERVIEW

The barrier island plan is authorized by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The purpose of this study is to determine whether the Louisiana barrier shoreline provides significant protection to Louisiana's coastal resources. If the study proves that the barrier shoreline provides these significant benefits, then this study will develop the most cost effective method to maximize those benefits.

The three year barrier island feasibility study is divided into three phases based on geographical location. Phase 1 is located between the Atchafalaya and Mississippi Rivers. Phase 2 encompasses the cheniere plain barrier formations in Vermilion and Cameron Parishes. Phase 3 focuses on the Chandeleur Islands. Phase 1 is the area currently being studied.

The project is structured to reach an implementation plan by starting from a broad descriptive analysis and gradually becoming more site-specific and detailed as the steps proceed. Each resource study or island option plan begins with some type of qualitative assessment and progresses to a more detailed quantitative analysis. For example: Step C qualitatively focuses on the status and trends of resources for the broad study area; whereas, Steps E and F will quantitatively assess and inventory the existing environmental and economic resources respectively. Also, Step I is a general evaluation of the needs and problems in the study area and development of management alternatives. Later, Step L will define the preferred plan criteria and chose a recommended implementation plan from the management alternatives developed in Step I, based on the quantitative assessments made in Steps J and K.

The first report completed for the barrier island feasibility study is Step A, which reviews prior studies, reports, and existing projects that pertain to the study's purpose, scope, and area. Step A also identifies and describes existing and potential barrier island and wetland restoration projects that affect the Phase 1 area. Step A is an overall orientation for the team on the project area. The literature review ensures that the team is knowledgeable and familiar with the most current literature available on the barrier islands and is using the most up-to-date information throughout the overall study.

Step B is also completed and contains a conceptual and quantitative framework for the barrier island study. The conceptual framework describes the functions and processes affected by barrier islands and the potential impacts on the significant resources in the study area. The significant resources include economic, cultural, recreational, and land-use resources. Step B also contains a review of the available methods for quantitatively predicting the effects of the barrier islands on environmental and economic resources. This information outlines the general study area for the team and describes the methodology that will be used in Step G to forecast physical and hydrological changes.

Step C provides qualitative assessments of the status and trends of the resources in the project area. A general study area map from Step B defines the area influenced by the barrier islands for the purposes of the Step C general resource assessment. These assessments include economic, social, cultural, water, biological, recreational, and land resources. In addition, the climatology, hydrology, and geological processes are analyzed with regard to their status and trends within the study area. Historical land losses are documented, as well as natural and human contributors to barrier island and wetland change. This information is gathered to demonstrate the characteristics of the study area and to show the resources at risk due to the loss of the barrier shoreline. It also orientates the team to the area and ensures the team will consider these resources in later steps.

Step D is a quantitative inventory of the physical parameters that are used to forecast changes in the economic and environmental resources. Step D involves delineating zones of environmental and economic analysis in the general study area described in Step B. The zones are designated using the Hurricane Andrew storm surge as criteria. The physical process parameters (waves, wind, sea level, sediment transport, etc.) and the geomorphic parameters (surficial sediments, topography, bathymetry) are identified, including data sources, type and quality of data, and any inconsistencies or "gaps" in the data. This information will be used as input for the modeling and forecasting effort in Step G. The results of Step D allow the team to evaluate the proposed modeling effort as outlined in Step B.

Step E provides a quantitative inventory and assessment of existing environmental resource conditions, with an emphasis on those resources considered significant. The team developed the criteria for determining "significant" environmental resources. Wildlife habitats, breeding grounds, and endangered species refuges are among those resources that have been assessed. Step E includes historical habitat/wetland change maps and describes the land loss rates and their associated changes. These data will be used to forecast the impact of the no-action scenario for environmental resources.

Step F is a quantitative inventory and assessment of existing economic resource conditions. This includes all structures, facilities, farmland acreage, and public resources (roads, channels, bridges, etc.) that are susceptible to the consequences of wetland/land loss, shoreline erosion, or hurricane induced flooding. The value of these economic resources and their residual worth will be included in the assessment. Historical damage and losses caused or induced by oil spills, waves, wetland/land loss, and shoreline erosion will also be evaluated. These data will be used to forecast the impact of the no-action alternative on economic resources.

The forecasted trends of physical and hydrological conditions will be discussed in Step G. A 30 year forecast of the present and future physical conditions will be modeled, showing the effects of a no-action scenario. The study will be conducted using the methods described in the Step B report and the data specified in the Step D report. Bathymetry and topography, waves, tides, storm surge, and other factors that affect the economic and environmental resources will be forecasted.

The effects on environmental resource conditions will be forecasted in Step H. Projected wetland/land loss will be presented for the 30 year no-action scenario. This will estimate, through the modeling results from Step G and projected trends, the total land loss and the effects on the wildlife that will be experienced within the thirty year period as present conditions proceed. At the completion of Step H, the team will have amassed information detailing the projected changes in the barrier shoreline and the anticipated effects of those changes on the environmental resources in the area. The team can then use this information as a baseline to compare other alternatives.

In Step I, the team begins to identify the options to be evaluated. This process will proceed through Steps J, K, L, and M. The later steps involve the identification and explanation of the preferred alternative(s). Step I involves identifying the problems, needs, and opportunities of the study area and developing strategic options. Options will be considered on an island-chain spatial scale. These options will include restoring a historical island configuration, establishing a fall back line, no-action alternative, preserving present-island configurations, strategic retreat, and other possible options. A general assessment of engineering, environmental, economic, and social factors regarding strategic option implementation will be considered. An array will be built comparing the different options with these factors. Those options that cannot be implemented because of cost, long-term effects, or other conditions will no longer be considered. The remaining options will become management alternatives and will be analyzed in greater detail in Step J. Step I will provide the necessary island size and inlet locations for the modeling study in Step J.

Step J is the assessment of management alternatives. The most important input for Step J is the identification of the specific management alternatives found in the Step I report. Step J includes qualitative and quantitative assessment of the management alternatives. This step includes a more detailed analysis of the effects of the proposed management alternatives on the environmental and economical resources of the area. For example, if a management alternative being investigated in Step J is a 1930 island configuration, then in Step J the increased flood protection potential from hurricanes by virtue of the size increase of the barrier islands will be described. That protection estimate will be an approximate dollar estimate and not a general assessment as was done in Step I. The output for Step J will be a detailed assessment of the effects of the management alternatives on the resources in the area. Resources include environmental, economical, and social. Where possible, the effects on resources will be quantified. The report should be based on a thirty year projection into the future and compared to the no action scenario.

Step K involves identifying and assessing possible management and engineering techniques for the management alternatives developed in Step I. Step K assesses the engineering techniques that may be used to implement the management alternatives identified in Step I. The long-term impacts will be used to assess the effectiveness of the various engineering and management techniques. This step will determine possible use of beach fill, coastal structures, and possible regulatory controls that will provide optimal design life and cost effectiveness. Shoreline prediction and dune-erosion models will be used (when applicable) on a site-specific scale to determine long-term shoreline change and erosion rates. Output from these methods will predict maintenance quantity and frequency. Dune crest height and berm and beach slopes will be determined for limiting wave runup and overtopping. Volumes of beach fill will be calculated after the beach and dune configurations are established. In addition, borrow site identification and assessment will be completed.

This will determine the cost, quantity available, and methodology for using various borrow sites for material if needed. The output for Step K will be the general applicability, cost, and impacts of various engineering alternatives.

Step L will be a description of the rationale for selecting a preferred plan. The criteria will be based upon the detailed assessments made in Steps J and K to develop a cost/benefit relationship. Step J will supply the benefits for each management alternative, while Step K details the cost. The selected management alternative and associated engineering and management techniques will be developed to form preliminary plans and cost estimates. Included will be all beach fill and coastal works concepts, sources of material, and cost of maintenance and monitoring.

In Step M, the team will select the preferred plan based on the criteria described in Step L. The team will then describe the methodology for instituting permitting, right-of-way/construction agreements, final engineering design, bidding, construction, mitigation, monitoring and maintenance. The preferred island configuration will be presented with potential structures, beach fill, dune restoration, and protection plans. Preferred sand sources and the effect of removing the sand will also be detailed. The Step M report will outline time, cost, and regulatory parameters.

Step N is a consolidation of all deliverables into one final report document. This final report will summarize the information provided in all previous documents.

FOREWORD

The purpose of this study is to determine whether the Louisiana barrier shoreline provides significant protection to Louisiana's coastal resources. The study will identify potential solutions to these problems, provide an economic evaluation, and determine the barrier configuration which will best protect Louisiana's coastal resources from wind/wave activity, saltwater intrusion, and oil spills.

In order to accomplish the desired goals and objectives, the study team, thus far, completed the following steps of the study:

Phase 1 - Step A - A Review of Pertinent Literature
Phase 1 - Step B - Conceptual and Quantitative System Framework
Phase 1 - Step C - Assessment of Resource Status and Trends
Phase 1 - Step D - Quantitative Inventory and Assessment of Physical Conditions and Parameters
Phase 1 - Step E - Inventory and Assessment of Existing Environmental Resource Conditions

This is the Step F report, which is an Inventory and Assessment of Existing Economic Resource Conditions in the Phase 1 study area. The objective of this report is to quantitatively inventory and assess baseline significant economic resources within the defined zone of economic analysis. Previous damages and loss of infrastructure, susceptibility to loss and damage of infrastructure and economic valuation of the infrastructure are included in the inventory and assessment. This information will be used to predict the economic effects on existing infrastructure for no-action and various alternatives.

The following have contributed to this part of the study:

T. Baker Smith & Son, Inc.
Wm. Clifford Smith, P.E., P.L.S.
Marc J. Rogers, Sr., P.E.
Stephen Smith, J.D.
Stephen Gilbreath, M.S.
Donald W. Davis, Ph.D.

Coastal Engineering and Environmental Consultants, Inc.
Oneil P. Malbrough, Jr., REM
Subrata Bandyopadhyay, Ph.D.
Murali M. Dronamraju, Ph.D., MBA

Applied Technology Research Corporation
Lawrence S. McKenzie, III, M.S.
Lorna Guynn

Louisiana State University
Mark R. Byrnes, Ph.D.
Randolph A. McBride, M.S.

Denise J. Reed, Ph.D.
Gregory W. Stone, Ph.D.
Joseph N. Suhayda, Ph.D.
Bruce A. Thompson, Ph.D.
Jingping Xu, Ph.D.
Paul Kemp, Ph.D.
Hassan Mashriqui, Ph.D.

TABLE OF CONTENTS

Page

PROJECT OVERVIEW i

FOREWORD vii

LIST OF TABLES ix

1.0 INTRODUCTION 1

2.0 PREVIOUS DAMAGES AND LOSSES TO FACILITIES, STRUCTURES, RESOURCES, AND PROJECTS 5
- 2.1 General Information 5
- 2.2 Hurricane Damages Since 1944 7
  - 2.2.1 Hurricane # 4 - September 4 -21, 1947 9
  - 2.2.2 Hurricane # 5 - September 1 - 7, 1948 10
  - 2.2.3 Hurricane Flossy - September 21 - 30, 1956 11
  - 2.2.4 Hurricane Audrey - June 25 - 29, 1957 12
  - 2.2.5 Hurricane Hilda - September 28 - October 5, 1964 14
  - 2.2.6 Hurricane Betsy - August 27 - September 13, 1965 15
  - 2.2.7 Hurricane Camille - August 14 - 22, 1969 17
  - 2.2.8 Hurricane Edith - September 5 - 18, 1971 19
  - 2.2.9 Hurricane Carmen - August 29 - September 10, 1974 20
  - 2.2.10 Hurricane Danny - August 12 - 20, 1985 24
  - 2.2.11 Hurricane Elena - August 28 - September 4, 1985 25
  - 2.2.12 Hurricane Juan - October 26 - November 1, 1985 26
  - 2.2.13 Hurricane Andrew - August 16 28, 1992 28
  - 2.2.14 Losses From Hurricane/Storm Induced Flooding 34
- 2.3 Coastal Erosion 39
- 2.4 Wetland Loss 40
- 2.5 Oil Spills 41
  - 2.5.1 General 41
  - 2.5.2 Greenhill Petroleum Company's Well No. 250 Spill in Timbalier Bay - Case Study 50

3.0 SUSCEPTIBILITY OF STRUCTURES AND FACILITIES TO LOSS AND DAMAGE 51

4.0 INVENTORY OF ECONOMIC RESOURCES 55
- 4.1 Residential Structures 55
- 4.2 Commercial Structures and Facilities 57
- 4.3 Industrial Structures 61

Page

	4.3.1	Background	61
	4.3.2	Oil and Gas Fields	61
	4.3.3	Oil and Gas Refineries	63
	4.3.4	Gas Processing Plants	64
	4.3.5	Pipelines	65
4.4		Port Facilities	69
4.5		Farmland and Agricultural Resources	75
4.6		Public Resources	82
	4.6.1	Schools	82
	4.6.2	Highways/Roads/Bridges	83
	4.6.3	Railroads	83
	4.6.4	Strategic Petroleum Reserve	85
	4.6.5	Airports	87
	4.6.6	Completed Wetlands Conservation Projects	87
	4.6.7	Flood Control, Navigation and Hurricane Protection Projects	89
		4.6.7.a. Flood Control Projects	90
		4.6.7.b. Navigation Channels	90
		4.6.7.c. Hurricane Protection Projects	97
	4.6.8	Coastal Restoration Projects Proposed	100
	4.6.9	Public Water Supply	102
4.7		Parks and Recreational Facilities	110
4.8		Archeological Sites	111

5.0		**VALUATION OF ECONOMIC RESOURCES**	115
	5.1	Value of Residential Structures	115
	5.2	Value of Commercial Property	116
	5.3	Value of Industrial Structures and Facilities - Oil and Gas	118
	5.4	Value of Port Facilities	119
	5.5	Value Agricultural Property and Crops	119
	5.6	Value of Public Resources - Schools	126
	5.7	Value of Public Resources - Highways, Roads and Bridges	127
	5.8	Value of Public Resources - Railroad Facilities	130
	5.9	Value of Public Resources - Strategic Petroleum Reserve	133
	5.10	Value of Public Resources - Airports	133
	5.11	Value of Public Resources - Completed Wetland Conservation Projects	133
	5.12	Value of Public Resources - Flood Control, Navigation, and Hurricane Protection Projects	134
	5.13	Value of Public Resources - Coastal Restoration Projects Proposed	135
	5.14	Value of Public Resources - Public Water Supply	135

Page

5.15 Value of Parks and Recreational Facilities 135
5.16 Value of Archeological Sites 136
5.17 Summary of Estimated Values 136

6.0 REFERENCES 139

7.0 APPENDICES A - M .... Attached

Appendix A - Hurricane/Storm Tracks
Appendix B - Land Loss Rates on the Mississippi River Delta Plain
Appendix C - Oil Spills
Appendix D - Residential Structures
Appendix E - Commercial Structures and Facilities
Appendix F - Industrial Structures: Oil and Gas Fields
Appendix G - Public Resources: Schools
Appendix H - Public Resources: Airports
Appendix I - Parks and Recreational Facilities
Appendix J - Estimated Values: Residential Structures
Appendix K - Schools Estimated Construction Cost - Classroom Space
Appendix L - Saffir-Simpson Scale of Potential Hurricane Damage
Appendix M - Selected Economic Resources Susceptible to Loss from Storm Surge

LIST OF TABLES

Pages

Table 1. Loss of Life by Community. 12

Table 2. Lower Cameron Parish Structure Damage 13

Table 3. Summary of Flood Damages: Hurricane Carmen. 20

Table 4. Areas Inundated by Flood Waters 21

Table 5. Damage to Parks and Recreational Facilities. 22

Table 6. Oil and Gas Industry Losses. 23

Table 7. Wind Damage - Hurricane Carmen 24

Table 8. Previous Damages and Losses: Hurricane Andrew. 33

Table 9. Hurricane Damages and Losses. 36

Table 9A. Number and volume of offshore spills greater than one barrel from Federal OCS lease facilities and operations in the Gulf of Mexico, 1987 through 1991. 46

Table 10. Selected Economic Resources Susceptible to Loss from Storm Surge 53

Table 11. Residential Structures in the Study Area - Summary. 57

Table 12. Commercial Establishments - Summary 60

Table 13. Industrial Structures: Oil and Gas Fields - Summary. 62

Table 14. Industrial Structures: Oil and Gas Refineries. 64

Table 15. Industrial Structures: Gas Processing Plants 65

Pages

Table 16. Industrial Structures: Pipelines. 67

Table 17. Port Fourchon....................69

Table 18. Port of South Louisiana. 70

Table 19. Plaquemines Parish Port. 71

Table 20. Port of West St. Mary. 72

Table 21. Port of New Orleans....................73

Table 22. Port of Morgan City. 74

Table 23. Farms - Acreage, Crop Types/Production....................78

Table 24. Public Resources - Schools. 82

Table 25. Public Resources - Highways, Roads, and Bridges - Miles. 83

Table 26. Public Resources - Railroads. 84

Table 27. Public Resources - Strategic Petroleum Reserve. 87

Table 28. Public Resources - Water Resource Projects - Completed Wetlands Conservation Projects. 89

Table 29. Gulf Intracoastal Waterway: Locks 93

Table 30. Public Resources - Water Resource Projects - New Orleans to Venice Hurricane Protection....................99

Table 31. Public Resources - Water Resource Projects - Coastal Restoration Projects. 101

Table 32. Public Resources - Water Resource Projects - Public Water Supply. 104

Table 33. Public Resources - Water Resource Projects - Ground Water Usage....................105

Pages

Table 34. Public Resources - Water Resource Projects - Surface Water Usage. 105

Table 35. Water Resource Projects - Housing Units by Source of Water. 106

Table 36. Water Resource Projects - Housing Units by Source of Sewage Disposal. 106

Table 37. Archeological Sites. 112

Table 38. Archeological Sites: Coding. 112

Table 39. Historic Structures. 114

Table 40. Residential Structures: Value Summary. 116

Table 41. Commercial Property: Fair Market Value or Use Value. 117

Table 42. Industrial: Oil and Gas Fair Market Values. 118

Table 43. Farms: Sales by Commodity Group 120

Table 44. Farms: Property and Crop Values. 121

Table 45. Schools: Estimated Construction Cost - Classroom Space Summary. 126

Table 46. Highways/Roads/Bridges: Cost Estimates 128

Table 47. Estimated Highway/Road/Bridge - Cost of Reconstruction 129

Table 48. Estimated Track Values Using Depreciated Assessments. 131

Table 49. Project Costs and Estimates 134

Table 50. Summary of Estimated Values 137

1.0 INTRODUCTION

In building a comprehensive economic assessment it is important that the assessment include resources consisting of accumulated human-made capital (buildings, equipment, inventories, and scientific and technological knowledge), human capital (skills and energy), and natural capital (soil, forests, minerals, water, and environmental conditions). Direct economic damages from natural hazard events may be measured through the use of six methods:

1. damages to human-made capital;
2. interruptions of production processes;
3. identification of economic activities to be measured over time;
4. damages to historical monuments and historical assets;
5. damages to human capital; and
6. damages to natural capital (Howe and Cochrane 1993).

The focus of this report is on human-made capital assets. The majority of quantifiable losses from natural hazard events occur due to damage to such assets (Howe and Cochrane 1993, p. 6). Human-made assets can be classified in one of four ways: long-lived business and government physical assets; business and government inventories of physical goods; non-business residential properties; and other non-financial personal property (Howe and Cochrane 1993). Figure 1 illustrates a damage analysis process for human-made capital assets.

Figure 1. Damage Analysis Process For Human-made Capital Assets.

➔ **Review Alternative Values for Assets**

Are they: book values (which may be outdated),
depreciated replacement value,
market values of similar assets, or
insurance and realtor records?

➔ **In terms of complete destruction of long-lived assets, will they be replaced?**

Yes → Damages = market value of similar asset.
No → Damages = present value of income losses resulting from loss of the asset.

➔ **In terms of partial destruction of long-lived assets, will they be rehabilitated?**

Yes → Damages = cost of rehabilitation
No → Damages = present value of income losses over the remaining operating life of the asset.

Source: Howe and Cochrane 1993.

The other five measurements of direct economic damages (losses) are: interruptions of production processes, identification of economic activities to be measured over time, damages to historical monuments and historical assets, damages to human capital, and damages to natural capital. These have not been evaluated in this report due to the limitations of the scope of work. Previous damages to all types of economic resources have been identified for later use in formulating an assessment of the loss of these resources.

This report is an inventory and assessment of existing economic resource conditions. The objective of this report is to quantitatively inventory and assess baseline significant economic resources within the defined zone of economic analysis, established in previous research. This zone contains all or parts of an eleven parish area including: Ascension, Assumption, Jefferson, Lafourche, Orleans, Plaquemines, St. Charles, St. James, St. John the Baptist, St. Mary and Terrebonne parishes. The eastern boundary of the study area is west of the Mississippi River levees. In the Barataria Basin, the zone extends northward of Lac Des Allemands and passes southward to Lake Boeuf. It encompasses the leveed areas of Terrebonne and Lafourche Parishes and extends westward from Donaldsonville to the Atchafalaya River eastern guide levee. The zone of economic analysis is shown in Appendix N.

The inventory and assessment includes three categories of economic resources: 1) private residential, commercial and industrial structures and facilities; 2) farmland and agricultural resources; and 3) public resources. The data and assessments for this plan were extracted from secondary data sources.

The assessment of the economic resources was achieved through various estimation methods using documented or established values. The calculated assessments are submitted as estimated replacement values - new construction or estimated abandonment costs - original documented construction costs.

The susceptibility of the economic resources identified in the inventory to storm/hurricane induced flood damages and susceptibility to loss or damage caused by oil spill, wave activity, wetland/land loss and shoreline erosion have been determined based on the previously documented damages by causal source of damage.

Previous losses in the study area were collected by causal source as reported. Research of the historical accounts of previous damages has shown an inconsistency of the reporting of losses by those agencies administering aid and/or declaring damage reports. These reported losses are doubtful as to accuracy or completeness. A discussion of these reporting inconsistencies is included in Section 2.0 of this report.

2.0 Previous Damages and Losses to Facilities, Structures, Resources, and Projects is proffered as a framework for a determination of susceptibility to similar damages. This is followed by **3.0 Susceptibility of Structures and Facilities to Loss and Damage**, **4.0 Inventory of Economic Resources**, and **5.0 Valuation of Economic Resources.**

2.0 PREVIOUS DAMAGES AND LOSSES TO FACILITIES, STRUCTURES, RESOURCES, AND PROJECTS

This section is a quantification of documented material pertaining to previous damages and losses. The section describes the damages and losses incurred due to causal sources such as hurricanes, coastal erosion, wetland loss, and oil spills.

2.1. GENERAL INFORMATION

A discussion of flood losses is impeded by the lack of uniform and systematic application of definitions of "flood" and "flood loss" applied to the collection of data from natural disasters. Even in the case of Presidential disaster declarations the accounting does not usually differentiate between flood-caused damages and damages caused by wind (Natural Hazards Research and Applications Information Center 1992).

There is no complete record of past flood damages in the United States. Reports indicate that due to differences in reporting flood losses and in adjusting dollar amounts to reflect changes in monetary values, as well as other problems in coordinating data sources, interpretation of flood loss data is difficult and estimates are not necessarily comparable. The two most comprehensive sources of annual flood loss data are the National Weather Service (NWS) and the American National Red Cross (Natural Hazards Research and Applications Information Center 1992).

The NWS has annually prepared estimates of damages caused by floods excluding agricultural losses and lives lost since 1902. These estimates are initially gathered using data from local NWS offices which is compiled from a variety of sources including government officials and the news media. Although a standardized form is used, no firm procedure or stringent requirements for completeness has been established by the NWS. Hence, data submitted by local offices may vary widely in quality. Until 1975 damage estimates were prepared by state. Beginning in 1976, only national totals were released by the NWS (Natural Hazards Research and Applications Information Center 1992).

Losses of infrastructure from natural hazards account for about one sixth to one fourth of total annual public and private losses (Natural Hazards Research and Applications Information Center 1992). Considering that site development costs typically average about 15 percent of total development costs and that approximately 25 percent of the structural wealth of the Nation consists of public utilities, highways and streets, and water and sewerage systems; the losses estimated to infrastructure seem reasonable (Natural Hazards Research and Applications Information Center 1992).

In the 1982 National Resources Inventory conducted by the Soil Conservation Service it was determined that cropland, pasture, range land, and forest land comprise over 90 percent of the total rural nonfederal floodplain land in the United States. In a 1975 study conducted by the U. S. Water Resources Council, it was estimated that 50 percent of annual flood damages affect the agricultural sector (Natural Hazards Research and Applications Information Center 1992).

On irrigated cropland, flooding can damage expensive irrigation facilities including ditches, pipelines and sprinklers. Sediment deposited by flood waters can cause two types of damage on cropland. One type is long-term loss on yield associated with the deposition of infertile material on good agricultural land. The value of this loss has not been estimated. The other type of loss is damage to current crops that occurs when growing crops or plants are covered with a thin film of sediment that interferes with the growth of the crops. This damage has been estimated at \$12 to \$99 per ha (\$5 to \$40 per acre) of flooded cropland, averaging about \$49 per ha (\$20 per acre) (Natural Hazards Research and Applications Information Center 1992).

It is with this understanding of the uncertainty of the accuracy of documented damage reports that previous damages and losses to facilities, structures, resources, and projects in the study area and along the Louisiana coast are presented herein.

2.2. HURRICANE DAMAGES SINCE 1944.

The hurricane damages described in this report are a compilation of information acquired from various studies and reports and newspaper articles including: *History of Hurricane Occurrences Along Coastal Louisiana*, published by the U.S. Army Corps of

Engineers, New Orleans District in 1961 and revised in August, 1972; *The Social and Psychological Consequences of a Natural Disaster: A Longitudinal Study of Hurricane Audrey*, published by the National Academy of Sciences, National Research Council; *Hurricane Carmen 7 - 8 September 1974*, published by the U.S. Army Corps of Engineers; *Data Archive of Atlantic Hurricane Tracking Data by Year* maintained at Colorado State University; *Natural Disaster Survey Report, Hurricane Andrew: South Florida and Louisiana, August 23 - 26, 1992*, published November, 1993 by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration; *Hurricane Andrew, A Strategy for Economic Recovery*, published by the Evangeline Economic and Planning District in Lafayette, LA; *Floodplain Management In The United States: An Assessment Report, Volume 2: Full Report*, published by the Federal Emergency Management Agency (FEMA); and various news articles from the archives of the *Chicago Tribune*. The "damages" presented within these reports are not necessarily reliable due to differences in reporting flood losses and in adjusting dollar amounts to reflect changes in monetary values, as well as other problems in coordinating data sources. In a report to the National Science Foundation in February 1989 concerning flood damage data, Thomas P. Grazulis stated, "This data base is a curious combination of intelligent, well-meaning and hard-working people being given minimal time to maintain a poorly conceived system with unsubstantiated data on a low priority basis. I haven't found anyone within the flood research community who actually believes the NWS (National Weather Service) numbers." (Howe and Cochrane 1993, p 1).

The tracking data presented in Appendix A includes all tropical storms and hurricanes for a fifty-year period, from 1944 to 1994. The wind speed in these data are reported in knots. It was noted by Chris Landsea, the researcher who compiled and maintains the data at Colorado State University, that the advent of aircraft reconnaissance in 1944 was the start of reliable seasonal statistics on the frequency and duration of storms. However, Landsea cautions that there is a bias in the best track data in that strong hurricanes were over-reported in wind-strength for the years 1944 to 1969. This bias amounted to a five knot overestimation at the 100 knot (115 mph; 51 m/s) threshold for major hurricane status. The amount of overestimation may be even worse for stronger storms (Landsea 1993).

There have been numerous tropical storms and hurricanes which caused damage to the Louisiana coast. The following descriptions are of those consequential hurricanes which have struck and significantly impacted Louisiana in the last 50 years for which documented damage data was available. Not all of these hurricanes impacted the study area; however, all with damage descriptions were included. This provides a more comprehensive assessment of the potential for hurricane/storm-induced flooding from future hurricane events.

2.2.1. Hurricane # 4 - September 4 - 21, 1947

It is estimated that Hurricane #4 reached wind speeds of 140 knots (160 miles per hour; 72 m/s) from the north just before the calm center (Landsea 1993). The lowest barometer reading was read at the New Orleans Weather Bureau office at 28.57 inches (72.57

centimeters). The entire Gulf coast from Florida to Louisiana experienced a tidal surge with the western end of the Mississippi Sound receiving the greatest buildup. Bay St. Louis was reported to have a high tide of 15.2 feet (4.63 meters) overtopping the seawall and inundating a considerable area inland. The maximum water surface elevation in Lake Pontchartrain was 6.0 feet (1.83 meters) at Mandeville and North Shore. Water rose over the seawall at the New Orleans lakefront causing flooding of the lakefront area (U.S. Army Corps of Engineers 1972).

The most severe flooding was in Jefferson Parish where the poor condition and low height of the lakeshore highway embankment allowed water in great sheets to top the embankment. Once inside, the water could not be removed because the ground level inside the embankment was lower than the lake level. The drainage pumps were not in operation for a considerable period of time. Water stood six feet deep in some areas. Moisant Airport had one half foot of water on the runways and could not operate. Other reported high tides in Louisiana were: Shell Beach, 11.2 feet (3.41 meters); Bohemia, 8.2 feet (2.50 meters); and Ostrica, 11.5 feet (3.51 meters). On the Gulf coast, 1,642 houses were destroyed and 25,000 damaged. The tidal damage in all areas was estimated at $110 million (1947 $). Fifty-one lives were lost, of which 12 were in Louisiana (U.S. Army Corps of Engineers 1972).

2.2.2. Hurricane # 5 - September 1 - 7, 1948

This hurricane passed inland just west of Grand Isle and moved over New Orleans on September 4. The highest wind was 70 knots (80 miles per hour; 36 m/s) (Landsea 1993) with gusts up to 78 knots (90 miles per hour; 40 m/s) reported at Moisant Airport (New Orleans International Airport). The heaviest reported damage was to oil rigs and equipment located in the vicinity of Grand Isle. High tides and heavy rainfall produced flooding in low areas. No lives were lost, but many people had to be evacuated to higher ground (U.S. Army Corps of Engineers 1972).

Crops suffered damage from wind and rain. Total damages were estimated at $1 million (1948 $). The tide in Lake Pontchartrain rose to 4.4 feet (1.34 meters) at West End. Other high tides reported were: Mobile, Ala., 5.3 feet (1.62 meters); Biloxi, Mississippi, 5.6 feet (1.71 meters); Chandeleur Island, 4 to 5 feet (1.22 - 1.52 meters); Burrwood, 3.4 feet (1.04 meters); and Grand Isle, 2.5 feet (0.76 meters) (U.S. Army Corps of Engineers 1972).

2.2.3. Hurricane Flossy - September 21 - 30, 1956

Hurricane Flossy reached hurricane strength on September 23, approximately 100 miles (160.93 kilometers) from the Louisiana coast. It turned sharply to the east-northeast, crossed the Mississippi River delta just north of Burrwood, and then passed inland near Fort Walton, Florida (U.S. Army Corps of Engineers 1972). The highest wind velocity estimated at Burrwood was 78 knots (90 miles per hour; 40 m/s) (Landsea 1993).

Heavy rains, varying in amount from 4 to 10 inches (10.16 - 25.4 centimeters) fell across southeastern Louisiana, southern Mississippi, southern Alabama, and northwest

Florida. Tides were unusually high along the coast from 20 miles (32.19 kilometers) west of Grand Isle to northwest Florida. High tides reported were: 13 feet (3.96 meters) at Ostrica Lock; 11 feet (3.35 meters) at Cox Bay; 10.5 feet (3.20 meters) at Potash Camp; and 10.9 feet (3.32 meters) at Shell Beach near Pointe a la Hache. Ostrica was almost entirely wiped out by flood waters coming from the bay side and flooding into the area, which is unprotected by back levees. Portions of the Mississippi River levee system suffered damage from bay water. Data are not available for monetary damages caused by this hurricane (U.S. Army Corps of Engineers 1972).

2.2.4. Hurricane Audrey - June 25 - 29, 1957

The highest sustaining winds recorded for Hurricane Audrey were 125 knots (144 miles per hour; 64 m/s) (Landsea 1993). The death toll for Audrey exceeded 400 persons in Cameron Parish alone. The storm surge hit the Cameron coastline between 2:30 AM and 6:00 AM, Thursday, June 27 causing great physical devastation over a 45-mile (72.42 kilometer) long area (Bates *et al.* 1963).

Table 1. Loss of Life by Community.

Community	Missing	Identified Dead	Total
Cameron	81	84	165
Creole	52	53	105
Grand Cheniere	17	22	39
Not Given	46	48	94
Total	196	207	403

Source: Bates *et al.* 1963, p. 22.

The destruction of two floating pontoon bridges, one crossing the Mermentau River and one crossing the Intracoastal Waterway, resulted in the total isolation of three areas of Cameron Parish. Further isolation resulted when the ferry over the Mermentau became inoperative. Through rescue efforts, over 1,200 persons were evacuated by water following the hurricane (Bates *et al.* 1963).

Many houses were destroyed or badly damaged. Numerous residents wanted to return home but were unable to due to unsanitary conditions left in the wake of Audrey. Over one half of the houses in the towns of Cameron, Creole, and Grand Chenier were lost. Some floated as far as 20 miles from their original locations. Over 80 percent of the houses in the parish suffered such severe damage they were considered uninhabitable (Bates *et al.* 1963).

Table 2. Lower Cameron Parish Structure Damage.

	Total Lower Cameron		Cameron		Creole		Grand Chenier	
Category	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Float-Outs	614	54.1	254	46.6	254	70.2	106	46.5
Off-Blocks	176	15.5	102	18.7	55	15.2	19	8.3
Great Damage	136	12	49	9	34	9.4	53	23.2
Slight Damage	187	16.5	123	22.6	19	5.2	45	19.7
Water Only	22	1.9	17	3.1	0	0	5	2.2
Totals	1,135	100	545	100	362	100	228	100

Source: Bates *et al.* 1963

Economic losses were paralyzing. Electrical power systems were inoperable. The water in wells was polluted. Debris was strewn everywhere. Of the approximate 80,000 cattle in the parish 60,000 died during the hurricane. The remaining 20,000 died soon after or were sold at a loss due to fear that they would soon die. The electrical and telephone company facilities and equipment were completely destroyed. School buildings, churches, roads, bridges, and business establishments suffered tremendous damage (Bates *et al.* 1963).

2.2.5. Hurricane Hilda - September 28 - October 5, 1964

Hurricane Hilda reached a wind speed of 130 knots (150 miles per hour; 67 m/s) on October 1, some 350 miles (563.25 kilometers) south of New Orleans (Landsea 1993). For the next two days Hilda took a northerly course while decreasing slightly in intensity. It crossed the Louisiana coast on October 3 south of Franklin. Maximum winds were 85 knots (98 miles per hour; 44 m/s) at the coast. Tornadoes were generated by the hurricane at Golden Meadow, Galliano, Larose, Kenner, Metairie, and New Orleans. The tornado that hit Larose caused 24 deaths, 345 injuries, and complete devastation to more than 27 homes. The town of Franklin was evacuated prior to the hurricane. Maximum winds reached 117 knots (135 miles per hour; 60 m/s) in this area, with rainfall in excess of 9 inches (22.9 centimeters). Iberia Parish recorded 17.71 inches (44.98 centimeters). Franklin sustained heavy wind damage but was spared from serious flooding. Hilda cause flooding of more than 3,000,000 acres (1,214,100 hectares) of land. Offshore and coastal oil installations suffered heavy damage and camps located along the south shore of Lake Pontchartrain in the Citrus-Little Woods area were damaged severely by high waves in the lake. Maximum reported flood stages were: Cocodrie, 7.8 feet (2.38 meters); Lake Pelto, 7.4 feet (2.26 meters); Leeville, 5.5 feet (1.67 meters); Chauvin-Montegut area, 7.0 feet (2.13 meters); Lower Atchafalaya River, 6.4 feet (1.95 meters); and West End, 5.3 feet (1.62 meters). Total damages were estimated above \$53 million (1964 \$). Thirty-nine persons lost their lives during Hurricane Hilda (U.S. Army Corps of Engineers 1972).

2.2.6. Hurricane Betsy - August 27 - September 13, 1965

Hurricane Betsy is considered one of the most destructive storms on record to hit the Louisiana coast (U.S. Army Corps of Engineers 1972). It reached hurricane strength on August 29 and began a westward movement for the following two days, reaching winds of 130 knots (150 miles per hour; 67 m/s) (Landsea 1993). The storm abated somewhat as it circled to south of the Florida coast. It entered the Gulf of Mexico on September 8, and began to intensify. The eye of the storm entered the Louisiana coast at Grand Isle between 9 PM and 10 PM on September 9, with wind speeds up to 139 knots (160 miles per hour; 82 m/s). Storm tides swept over Grand Isle and practically all buildings except the church, the U. S. Coast Guard Station, and a housing development owned by a major oil company were swept away, demolished, or severely damaged by the onrushing surge and waves. East of Grand Isle, storm surge inundated the Venice-Buras-Empire and Port Sulphur areas with water depths up to 11.5 feet (3.51 meters). Storm surges overtopped the back levee in the

Bohemia-Pointe a la Hache-Phoenix area, flooding and heavily damaging all structures located within the area. Further north and east, practically all communities were flooded and suffered heavy damage including the areas of: Delacroix, Reggio, Hopedale, Yscloskey, Alluvial City, Shell Beach, and Verret. In addition to flooding, many structures were washed off foundations and floated some distance away (U.S. Army Corps of Engineers 1972).

The eastern portion of New Orleans and the Chalmette area suffered severe damage from floodwaters and winds. Many camps and homes located along Chef Menteur, Rigolets, Lake St. Catherine, and on the south shore of Lake Pontchartrain were completely demolished or heavily damaged by the combination of floodwaters, wind, and waves. Flooding depth reached a high of about 9 feet (2.74 meters) in these areas (U.S. Army Corps of Engineers 1972).

Damages related to Hurricane Betsy were estimated at over $2 billion (1965 $). More than two and one half million acres (1,011,750 hectares) of land were flooded; approximately 300,000 persons were evacuated or changed living quarters; and more than 27,000 homes were destroyed or flooded. Offshore and coastal oil installations reported unprecedented damage. Sugarcane, pecan and fall crops were heavily damaged and considerable livestock drowned. Severe damage resulted to all types of fish and wildlife. Deaths in Louisiana resulting from Hurricane Betsy are listed at 81 persons. This death toll could have been higher if residents of low lying areas had not heeded warnings and evacuated (U.S. Army Corps of Engineers 1972).

Recorded flood stages were as follows: Mississippi River west of Pointe a la Hache, 15.2 feet (4.63 meters); Chalmette, 12.3 feet (3.75 meters); New Orleans, 12.4 feet - a rise of 10. 2 feet (3.78 meters); Bonnet Carre, 13.1 feet (3.99 meters); Pointe a la Hache, 14.4 feet (4.39 meters); Ostrica, 13.6 feet (4.15 meters); Empire, 10.4 feet (3.17 meters); Venice, 8.8 feet (2.68 meters); Phoenix, 8.3 feet (2.53 meters); Delacroix, 11.0 feet (3.35 meters); Yscloskey, 11.7 feet (3.57 meters); Shell Beach, 9.3 feet (2.83 meters); Violet 10.1 (3.08 meters); Lake Borne at Rigolets, 10.6 (3.23 meters); Rigolets at Highway 90, 7.0 feet (2.13 meters); Chef Menteur at Highway 90, 9.1 feet (2.77 meters); Paris Road (Mississippi River Gulf Outlet), 9.0 feet (2.74 meters); Seabrook Bridge, 6.2 feet (1.89 meters); Causeway (mid-lake), 5.5 feet (1.68 meters); West End, 7.6 feet (2.32 meters), Mandeville, 6.5 feet (1.98 meters); Frenier, 12.1 feet (3.69 meters); Biloxi, 8.6 feet (2.62 meters); Gulfport, 10.7 (3.26 meters); Lake Maurepas, 4.1 feet (1.25 meters); Leeville, 5.4 feet (1.65 meters); Grand Isle, 8.8 feet (2.68 meters); South Pass Bar, 5.5 feet (1.68 meters); and Head of Passes, 6.6 feet (2.01 meters) (U.S. Army Corps of Engineers 1972).

2.2.7. Hurricane Camille - August 14 - 22, 1969

Hurricane Camille struck the coast of Mississippi just east of the Louisiana State Line. It caused widespread destruction and serious loss of lives (U.S. Army Corps of Engineers 1972). Winds were estimated to be 139 knots (160 miles per hour; 72 m/s) (Landsea 1993) with estimated wind gusts at 174 knots (200 miles per hour; 90 m/s) at the Waveland-Bay St. Louis area. The high-water mark reached 22.6 feet (6.9 meters) mean sea level at Pass Christian, Mississippi. Surges of 15.0 feet (4.58 meters) or more extended from Waveland to Ocean Springs, Mississippi. Monetary damages as a result of Camille were in excess of $1 billion (1969 $). Two hundred and sixty-two lives were lost, nine of these deaths were in Louisiana (U.S. Army Corps of Engineers 1972).

In Louisiana, the area from Venice to Buras was almost completely destroyed. Oil, sulphur, and fishing industries suffered severe damages. Maximum flood stages resulting from Hurricane Camille were: Mississippi River-Inner Harbor Navigation Canal Lock, 11.5 (3.51 meters); Chalmette, 11.3 feet (3.44 meters); Algiers Lock, 11.4 feet (3.47 meters); West Pointe a la Hache, 11.8 feet (3.60 meters); Empire, 10.9 feet (3.32 meters); Fort Jackson, 15.3 feet (4.66 meters); Ostrica Lock, 15.9 feet (4.85 meters); Venice, 9.1 feet (2.77 meters); Boothville, 14.6 feet (4.45 meters); Buras, 13.4 feet (4.08 meters); Sunrise, 10.9 feet (3.32 meters); Bohemia, 11.0 feet (3.35 meters); Hopedale, 8.9 feet (2.71 meters); Yscloskey, 8.0 feet (2.44 meters); Shell Beach, 11.1 feet (3.38 meters); Mississippi River Gulf Outlet at Paris Road, 9.7 feet (2.96 meters); Inner Harbor Navigation Canal at Florida Avenue, 9.8 feet (2.99 meters); Seabrook Bridge, 6.5 feet (1.98 meters); Citrus, 7.0 feet (2.13 meters); Little Woods, 6.9 feet (2.10 meters); Irish Bayou, 7.2; vicinity of Highways 11 and 90, 7.6 feet (2.32 meters); Chef Menteur, 8.7 feet (2.65 meters); Highway 90 near Lake Catherine, 10.0 feet (3.05 meters); Rigolets, 9.0 feet (2.74 meters); Rigolets at Long Point, 12.3 feet (3.75 meters); and Bayou Bonfouca near Slidell, 6.8 feet (2.07 meters) (U.S. Army Corps of Engineers 1972).

2.2.8. Hurricane Edith - September 5 - 18, 1971

Hurricane Edith came ashore in Louisiana between Grand Cheniere and the Rockefeller Wildlife Refuge on September 16. Highest winds measured onshore were 60 knots (69 miles per hour; 31 m/s), with gusts to 83 knots (96 miles per hour; 43 m/s) at Cameron (Landsea 1993). Only moderate buildup of tides was experienced along the Louisiana coast ranging from 5 to 8 feet (1.52 - 2.44 meters). The hurricane spawned several tornadoes; the most serious of which damaging residences, schools, and shopping centers in eastern Baton Rouge. Damages were classed as light-to-moderate in southern Louisiana. The greatest damage was suffered by crops, with some damage also reported to roads, levees, and drainage structures near Rockefeller Wildlife Refuge and Marsh Island Wildlife Refuge Areas (U.S. Army Corps of Engineers 1972).

Maximum hurricane stages reported were: Cameron, 4.3 feet (1.31 meters); Grand Cheniere, 5.9 feet (1.80 meters); Freshwater Bayou Lock, 7.4 feet (2.26 meters); Schooner Bayou Lock, 4.6 feet (1.40 meters); Vermilion Lock, 4.0 feet (1.22 meters); Charenton Drainage Canal near Baldwin, 5.2 feet (1.58 meters); Calumet, 5.5 feet (1.68 meters); Morgan City 5.8 feet (1.77 meters); and Bayou Boeuf Lock, 6.0 feet (1.83 meters) (U.S. Army Corps of Engineers 1972).

2.2.9. Hurricane Carmen - August 29 - September 10, 1974

Hurricane Carmen's highest sustaining winds were 130 knots (150 miles per hour; 67 m/s) (Landsea 1993). Tidal surges from the Gulf and tidal overflows from lakes, bayous and bays located in the Louisiana coastal area were the major causes of flooding. Minor damages were produced by rainwater flooding (U.S. Army Corps of Engineers 1975).

Table 3. Summary of Flood Damages: Hurricane Carmen.

Category	Damage ($ Thousands)
Separable losses (Flood damages only)	
Urban	749.0
Rural Developed	3,052.0
Agricultural	1,132.0
Government	189.0
Transportation	144.0
Petroleum and Natural Gas	12,000.0
Subtotal: separable losses	17,266.0
Nonseparable losses (costs cannot be separated between those induced by wind and those induced by water)	
Government	359.0
Fish and Wildlife Resources	Not documented.
Navigation	Negligible
Miscellaneous	651.0
Subtotal: nonseparable losses	1,010.0
Totals	18,276.0

Source: U.S. Army Corps of Engineers, 1975 pp 43 -44.

Extensive acreage within the study area was inundated by flood waters due to Hurricane Carmen. The pattern of overflow by land-use categories is presented in Table 4.

Table 4. Areas Inundated by Flood Waters.

	Land - Use Category (in acres)					
Parish	Urban	Rural Developed	Agricultural	Wooded	Other (includes marsh)	Acres
Jefferson	0	1,900	10,000	13,700	131,000	156,600
Lafourche	0	4,200	15,400	22,300	448,200	490,100
Orleans	800	0	0	0	39,400	40,200
Plaquemines	400	300	5,700	1,700	582,500	590,600
St. Charles	0	2,000	300	18,300	71,600	92,200
St. John	0	0	0	58,200	0	58,200
St. Mary	400	0	6,100	72,500	131,300	210,300
Terrebonne	2,400	4,600	11,700	63,800	659,800	742,300
Totals	4,000	13,000	49,200	250,500	2,063,800	2,380,500

. Source: U.S. Army Corps of Engineers 1975 pp 78.
(1 acre = 0.4047 hectare)

It was reported in the study of Hurricane Carmen by the U. S. Army Corps of Engineers that excessive tidal action induced an abrupt increase in the salinity of coastal waterbodies and low-lying marshes, and physically destroyed shallow water bottoms and marshes. In some areas, saltwater intrusion placed severe stress on plant life. Other areas suffered a range of damaging impact which varied from the extreme to nondetectable. This was dependent on the increase in salinity and the duration of the situation. Documentation of losses to fishery resources was not available. Observed, but unquantifiable effects included: dispersion of young shrimp utilizing the estuaries as nursery grounds, damage to oysters induced by deposition of silt and debris on beds, dispersion of menhaden schools making them uneconomical to harvest, and fish kills resulting from the loss of dissolved oxygen due to increased organic loads (U.S. Army Corps of Engineers 1975).

Terrestrial wildlife drowned due to inundation of land areas by high tides and waves. The alteration of habitat by wave action and saltwater intrusion also adversely affected wildlife resources (U.S. Army Corps of Engineers 1975).

Four parks in Louisiana sustained damage as a result of Hurricane Carmen. Table 5 portrays the estimated damages to the parks' facilities and the estimated usage lost. Grand Isle, Fort Pike and Fairview-Riverside received most damages through flooding. Longfellow-Evangeline, which is situated inland, sustained damages exclusively from high winds (U.S. Army Corps of Engineers 1975).

Table 5. Damage to Parks and Recreational Facilities (1974 $).

Park	Value of Lost Usage $	Damages $	Total Loss $
Grand Isle	103,300	11,300	114,600
Fort Pike	1,200	300	1,500
Longfellow-Evangeline	87,300	2,000	89,300
Fairview-Riverside	5,600	300	5,900
Total	197,400	13,900	211,300

Source: U.S. Army Corps of Engineers 1975.

Total damages to the oil and gas industry were estimated to be $24.7 million (1974 $). Of this total only $12 million were attributable to water-related damage. Table 6 lists offshore and onshore damages in dollars caused by flooding and wind. Damages were primarily caused to physical equipment and facilities, including wells, electric motors, pipes, and tanks. Other damages included in the totals were rehabilitation of fields, roads, and canals (U.S. Army Corps of Engineers 1975).

Table 6. Oil and Gas Industry Losses.

Area	Flood $	Wind $	Total $
Onshore production facilities	1,650,000	680,000	2,330,000
Offshore production facilities	10,350,000	12,020,000	22,370,000
Totals	12,000,000	12,700,000	24,700,000

Source: U.S. Army Corps of Engineers 1975.

Production losses were estimated at 1.4 million barrels of oil and 15,385 million cubic feet (435.66 cubic meters) of natural gas. Most wells were at full production capacity prior to the storm. Production down time, as a result of the storm, was 24 to 48 hours (U.S. Army Corps of Engineers 1975).

Utility companies in the coastal area sustained estimated damages of $800,000 (1974 $). These damages were the result of falling trees and flying debris from strong winds. Most service was restored to the area within 24 hours (U.S. Army Corps of Engineers 1975).

Wind damage was sustained by approximately 1.2 million acres (485,640 hectares) of cleared agricultural lands. The primary crops damaged were sugarcane, soybeans, rice, and cotton. These losses were valued at $74 million (1974 $) based on reduced crop yields (U.S. Army Corps of Engineers 1975). Table 7 provides a description of total damages due to high winds.

Table 7. Wind Damages - Hurricane Carmen.

Category	Damage $
Urban	500,000
Rural	300,000
Agricultural	74,000,000
Government	900,000
Total	75,700,000

Source: U.S. Army Corps of Engineers 1975, pp 73.

2.2.10. Hurricane Danny - August 12 - 20, 1985

Hurricane Danny made landfall near the coastal community of Pecan Island, LA. on Thursday, August 15, 1985. The 80-knot (92 miles per hour; 41 m/s) winds (Landsea 1993) and torrential rains touched off tornadoes and floods, damaging buildings along a 250-mile (402.32 kilometer) stretch of the Gulf coast. Civil defense officials reported no deaths and few serious injuries. Louisiana Governor Edwin Edwards declared a state of emergency in 13 parishes affected by the storm. In some areas, ten inches (25.4 centimeters) of rain were reported. Hardest hit, according to Tom Creaghan, director of the state's Office of Emergency Preparedness, was the state's coastline and the parishes in the Lafayette region: Vermilion, Iberia, Lafayette, and St. Mary. An estimated 15,000 residents along the coast and another 20,000 workers on oil rigs in the Gulf were evacuated inland. Police in Grand Isle reported two tornadoes causing roof damage to several buildings. Strong southerly winds pushed tides 7 to 9 feet (2.13 - 2.74 meters) above normal into bayous and canals along the coast, spilling saline floods over low-lying fields and marshes (Chicago Tribune 1985). The Marsh Island State Wildlife Refuge suffered serious damages when the impoundment's levees collapsed, allowing salt water to flood the freshwater habitat. Marsh Island was covered with four feet (1.22 meters) of water for three days, destroying food and cover for waterfowl. Two water control structures and the levees surrounding the habitat have been restored through the Ducks Unlimited "MARSH" (Matching Aid to Restore State Habitat) project (*Chicago Tribune* 1987).

The Louisiana Office of Emergency Preparedness reported that Danny damaged approximately 15,000 ha (38,000 acres) of crops in southwestern Louisiana valued at $10 to $13 million. Damages caused by winds and floods to private and public facilities were estimated at $7 to $10 million. No significant damage to Corps facilities or structures was reported (US Army Corps of Engineers 1987).

2.2.11. Hurricane Elena - August 28 - September 4, 1985

Hurricane Elena pushed ashore near Gulfport, Mississippi on September 2, 1985. Winds were estimated to be 110 knots (127 mph; 57 m/s) (Landsea 1993). It missed New Orleans, passing to the northeast and damaging parts of Bogalusa and Franklinton, LA. Bob Sheets, Acting Deputy Director of the National Hurricane Center near Miami stated, "The damage is large. It's well over $1 billion (1985 $) and I wouldn't be surprised if it was $2 billion." (*Chicago Tribune* 1985).

Rising tides covered roads in St. Bernard Parish and flood gates were closed along Lake Pontchartrain near New Orleans. An estimated 200,000 residents were evacuated in the New Orleans area. At least 17,390 dwellings in Mississippi, Alabama, Florida, and Louisiana sustained some damage during the storm, according to estimates by the American Red Cross and other officials. Mayor Louis Rawls of Bogalousa, LA, said up to 100 houses, including his own, were damaged by Hurricane Elena. He estimated damage at $3 million (1985 $). Pascagoula, Mississippi and surrounding smaller towns near the Alabama border were hardest hit by the storm. Ingalls Shipyards and the Chevron USA refinery received extensive damages. The Coast Guard reported that ports along the coast closed because many buoys and channel markers had blown off position. These ports remained closed until the Coast Guard completed their inspections and repairs (Chicago Tribune 1985).

The American Insurance Services Group, Inc. (AISG) rated Hurricane Elena as the "fourth costliest hurricane ever in terms of insured property losses, which totaled $543.3 million (1985 $). The heaviest property damage, $352.4 million (1985 $), occurred in Mississippi." Regional Manager of the AISG, Bill Davis, reported insured damage in Alabama of $100.3 million (1985 $), in Florida of $46.8 million (1985 $), and in Louisiana of $13.8 million (13.8 $). The total for vehicles, boats and miscellaneous amounted to $30 million (1985 $) (*Chicago Tribune* 1985). A US Army Corps of Engineers report of the 1985 hurricane season also reported $13.8 million in insured losses, with an addition $3 million of uninsured losses. There was approximately $500,000 in agricultural losses. There were no deaths reported as a result of Hurricane Elena (US Army Corps of Engineers 1987).

2.2.12. Hurricane Juan - October 26 - November 1, 1985

After stalling along the Louisiana coast south of Lake Charles Hurricane Juan made landfall south of Houma, LA. Winds were estimated to be 75 knots (86 mph; 38 m/s) (Landsea 1993). Bayou Lafourche floodwaters inundated the communities of Golden Meadow, Galliano, Cutoff, and Larose. In Westwego, floodwaters breached 200 feet (60.96 meters) of levee protecting the city from surrounding swampland. Floodwaters spilled out of Lake Pontchartrain, causing more than 3,000 people to evacuate their homes in St. Charles, St. James, and St. John the Baptist parishes (*Chicago Tribune* 1985).

Hal Gerrish, a forecaster for the National Hurricane Center near Miami, stated that Hurricane Juan did not behave like a typical hurricane. "Its eye was ill-defined and more than 50 miles (80.46 kilometers) across, and its winds, rather than being concentrated toward the center, were in broad bands that stretched across the entire gulf." (*Chicago Tribune* 1985).

Deaths as a result of Hurricane Juan totaled eleven (US Army Corps of Engineers 1987). In Louisiana, Governor Edwin Edwards reported 50,000 flooded homes and about $110 million (1985 $) in damage to sugarcane and other unspecified damage added up to about $1 billion (1985 $) in damages. A dollar estimate of offshore damages was not available, but several multi-million dollar oil rigs were lost or seriously damaged (*Chicago Tribune* 1985). Reports from the Louisiana Office of Emergency Preparedness estimated over

$554 million in damage to property and crops was caused by flooding within Louisiana (US Army Corps of Engineers 1987). There was no distinction made between storm surge flooding and flooding caused by excessive rainfall.

2.2.13. Hurricane Andrew - August 16 - 28, 1992

The highest sustaining winds for this storm were 135 knots (155 mph; 69 m/s) (Landsea 1993). Prior to landfall across the Louisiana coast on August 26, 1992, Hurricane Andrew had weakened to a Category 3 hurricane. Its maximum sustained winds were estimated at 120 miles per hour with higher gusts. The storm came ashore near Point Chevreuil, about 20 miles (32.2 kilometers) west-southwest of Morgan City with an estimated central pressure of 956 millibars. Andrew weakened rapidly to tropical storm strength by early afternoon and to a depression by evening. On August 28, the remnants of Andrew merged with a cold front and were no longer considered a tropical weather system (U.S. Department of Commerce 1993).

Damages for the 36-parish disaster area from Andrew were estimated to exceed $1 billion (1992 $). Much of the estimated losses were insured: 3,301 single family, multifamily, and mobile homes were destroyed; 18,247 housing units received major or minor damages. The storm's effect on Louisiana public utilities was minimal. Quick action by local and Louisiana state officials promoted both rapid response to the disaster and immediate launching of a coordinated recovery effort (U.S. Department of Commerce 1993).

Data compiled by a consortium of state agencies and groups with specific responsibilities in agriculture indicated that estimated agricultural losses would exceed $288 million (1992 $). Sugarcane yield losses were estimated at $128.4 million (1992 $), cotton losses at $68.2 million (1992 $), and forestry-related losses at $38.6 million (1992 $). The consortium also estimated losses of $13.2 million (1992 $) for the soybean crop, $12.7 million (1992 $) for corn, and $9.1 million (1992 $) for rice (U.S. Department of Commerce 1993).

Human casualties were surprisingly few. Eight (8) direct and nine (9) indirect fatalities occurred. This low number is attributed to accurate forecasts, effective preparations, and to the limited effect of the storm surge (U.S. Department of Commerce 1993).

Hurricane Andrew is considered the most expensive natural disaster in United States history in terms of property loss. Most damage was caused by severe winds rather than storm surge. The tornado at La Place was the most damaging Andrew-related element to manmade structures in Louisiana (U.S. Department of Commerce 1993).

The hydrologic impact of Hurricane Andrew was generally minimal. Although extensive rainfall fell at some locations, there were no reports of major flooding. For Louisiana, Hurricane Andrew's rainfall pattern was similar to past hurricanes striking the central Gulf coast region: Hurricane Betsy - September 1965, and Hurricane Camille -

August 1969. For Betsy and Camille, the heaviest rains were generally along and to the east of the paths of the hurricanes. Likewise, the heaviest rainfall associated with Hurricane Andrew was also along and to the east of the path of the hurricane, although the rainfall pattern was somewhat more widespread than with Betsy and Camille. Maximum observed rainfall amounts were similar for all three hurricanes (U.S. Department of Commerce 1993).

Despite the heavy rainfall, very little significant reported flooding developed in Louisiana and surrounding states. This was primarily due to the fact that hydrologic conditions prior to Andrew's arrival were quite dry. Most rivers were at their low, mid-summer stages, and soils across much of the Lower Mississippi Valley were very dry. As an indication of dry conditions, several calculations were done by the National Weather Service which compared the volume of rainfall with runoff passing forecast points in Louisiana and Mississippi. These calculations indicated that only 25 percent, or less, of the volume of rain that fell actually moved into the rivers as runoff. The remaining 75 percent was absorbed by dry soils or plants or it evaporated. Minor to moderate flooding did develop along several rivers in Louisiana including the Tangipahoa, Bogue Falaya, Tickfaw, Tchefuncte and Pearl.

The greatest river rise occurred along the Tangipahoa River at Robert, LA, where a rise of 11 feet (3.35 meters) in the river stage occurred, resulting in a crest of 18.8 feet (5.73 meters), or 3.8 feet (1.56 meters) above flood stage. This rise resulted from a concentrated 8 to 11-inch (20.32 - 27.94 centimeters) rainfall associated with one of Andrew's feeder bands moving across the Tangipahoa basin. The flooding inundated some river camps, recreational areas, and adjacent floodplain farmland, but damages were generally minor (U.S. Department of Commerce 1993).

Much of the Louisiana coastal area is near sea level and, therefore, highly vulnerable to storm surge. Forecast surge height values for the Louisiana coast for Hurricane Andrew were predicted to reach values of 10 to 15 feet (3.05 - 4.57 meters). Actual surge height values measured from 5 to 8 feet (1.52 - 2.44 meters). The disparity between the forecasted surge and the actual is attributed to the change in storm intensity just prior to landfall. The diameter of the storm's eye had decreased and the radius of maximum winds decreased from approximately 25 miles (40.23 kilometers) to 14 miles (22.53 kilometers) during this period. These changes in the hurricane's characteristics are beyond the current forecasting capabilities of the National Hurricane Center. In Louisiana, the highest storm surge mark was recorded at Luke's Landing along East Cote Blanche Bay, where 8.2 feet (2.50 meters) was observed at the U.S. Army Corps of Engineers water-level gauge. Several other gauges recorded surge heights over 6 feet (1.83 meters) during Andrew. Lake Pontchartrain was raised to a level of approximately 4.5 feet (1.37 meters). These surge heights occurred shortly before the normal astronomical high tide. In the area impacted by Andrew, this would have added approximately one (1) foot (0.3048 meters) to the observed readings. Tidal traces indicate that prior to Andrew's landfall, water was being forced away from the coastline by offshore winds, resulting in depressed water levels (below mean sea level). As the eye passed and the winds shifted to onshore, water levels rose rapidly and reached their observed peaks (U.S. Department of Commerce 1993).

The majority of flood damage caused by Hurricane Andrew was storm-surge-related and occurred in Lower Terrebonne Parish. Damage, in general, was minimal as surge values were half their expected levels in the vicinity of Cocodrie: 7 - 9 feet (2.13 - 2.74 meters), Dulac and Chauvin: 4 - 5 feet (1.22 - 1.52 meters), and Montegut: 2 - 4 feet (0.61 - 1.22 meters) (U.S. Department of Commerce 1993).

Louisiana fisheries received a severe blow. Louisiana Department of Wildlife and Fisheries biologists estimated conservatively that the freshwater fish kill valuation reached nearly $160 million (1992 $) (U.S. Department of Commerce 1993). Of this total, nearly 5 million were Large-mouth Bass valued at $21 million (1992 $). In the Atchafalaya Basin, it was estimated that nearly 182 million freshwater fish died. Saltwater fish biologists compiled fish kill counts at beaches and bays in southern Terrebonne Parish. They calculated that 9.4 million fish suffocated as of August 31 (U.S. Department of Commerce 1993).

The loss of these native fish was estimated at $8 million (1992 $). Biologists also estimated the coastal sports industry suffered a loss of $12 million (1992 $) during September and October of 1992. The marine recreational fishing industry depends on the accessibility to coastal waters and the availability of marine facilities. Both suffered greatly due to the effects of Andrew (U.S. Department of Commerce 1993).

The commercial fishing industry was also heavily impacted. Louisiana generally harvests 3.5 million pounds of seafood during September and October at an estimated retail value of $210 million (1992 $). It was estimated the industry experienced an immediate loss of $54 million (1992 $). This figure does not reflect the direct physical damage to shoreside support facilities or the loss of markets. Similar losses were inflicted on wildlife resources, furbearers, and alligators (U.S. Department of Commerce 1993).

The Gulf coast is dotted by numerous submerged wells and oil well structures (platforms), including appurtenances, such as satellite wells and oil pipes. The largest concentration of oil platforms, and drilling rigs are located off the Louisiana coast. The total number of production structures is approximately 3,800, including about 150 oil drilling rigs. These facilities are extremely vulnerable to hurricanes. Their destruction poses a major threat to both the ecology and economy of the Gulf region and the Nation. Estimates of total losses from the repair of damaged equipment, replacement of equipment, and clean-up costs exceeded $250 million (1992 $) (U.S. Department of Commerce 1993).

Table 8. Previous Damages and Losses: Hurricane Andrew.

Damages	Number
Platforms Toppled	14
Platforms Leaning	4
Satellites Toppled	31
Satellites Leaning	82
Structural Damage	112
Pollution Incidents	7
Fires	2
Drift	5

Source: U.S. Department of Commerce. National Oceanic and Atmospheric Administration. 1993.

In addition to platforms damaged, 309 pipelines were damaged. Damage also occurred on oil storage tanks both onshore and offshore. The Ship Shoal and South Timbalier areas suffered the most damage to their pipeline network. The damage to the various petroleum networks is congruent to the region along Andrew's track where the greatest damage would be expected. The petroleum industry estimates a one-half billion dollar (1992 $) loss due to the damaged equipment and the interruption of operations caused by Hurricane Andrew (U.S. Department of Commerce 1993).

Andrew affected an unknown number of commercial ships, recreational vessels, and barges throughout the Mississippi basin and the northern Gulf coast. Documentation provided by the U.S. Coast Guard, District Eight, revealed that a number of ships were lost, and rescue efforts had to be conducted. Louisiana was spared major damage since Andrew missed the major boating areas north and east of New Orleans. Many boaters had enough advanced warning and moved their vessels out of the path of the storm up into one of Louisiana's many bayous, where they had more protection. No formal estimate of monetary loss has been computed for commercial and recreational marine interests as a result of Hurricane Andrew (U.S. Department of Commerce 1993).

2.2.14. Losses From Hurricane/Storm-Induced Flooding

With improvements in technology, hurricane forecasters can now predict storm path and intensity with relative accuracy. Residents are forewarned of the impending danger, voluntarily evacuating and, in some cases, evacuated through enforcement. The death toll has declined with these improved warning systems. However, technology has also provided the means by which more of the population can reside and develop property near the coast in previously uninhabited areas. Businesses are built; infrastructure is developed to meet the needs of the growing population. This places more economic resources "at risk" should a hurricane strike. Losses from storm surge and flooding will increase unless measures are taken to protect or reduce these devastating impacts.

Table 9. Hurricane Damages and Losses.

Location or Resource	Hurricane #4 9/4/47	Hurricane #5 9/1/48	Flossy 9/21/56	Audrey 6/25/57
Gulf coast	1,642 houses destroyed, 25,000 damaged. Tidal damage estimated at $110 million. 51 lives lost, 12 in LA.	Damage estimated at $1 million.		
Louisiana or Louisiana coastal areas			Mississippi River Levee system damaged from bay water flooding.	Over 400 persons died in Cameron Parish. Storm surge impacted a 45 mile long area. Two pontoon bridges destroyed. Electric and phone service devastated. 80% of structures damaged.
Jefferson	Heaviest flooding.			
Lafourche Orleans				
Plaquemines			Ostrica damaged extensively by flood waters from bay side.	
Terrebonne				
Offshore oil rigs		Heaviest damage to rigs located offshore from Grand Isle.		
Agricultural resources				Severe losses to livestock.

Table 9. Hurricane Damages and Losses. (*continued*)

Location or Resource	Hilda 9/28/64	Betsy 8/27/65	Camille 8/14/69	Edith 9/5/71
Gulf coast			Damages in excess of $1 billion. 262 lives lost - 9 in LA. Storm surges of 15 feet or more along the coast. Oil, sulphur and fishing industries-severe damage.	
Louisiana or Louisiana coastal areas	Flooding occurred over 3 million acres of land. Total damages - $53 million. 39 persons died.	Damages estimated at over $2 billion. 2.5 million acres of land flooded. 27,000 homes damaged or destroyed. Sugarcane and pecan crops heavily damaged - livestock drowned. 81 persons died in LA.		Several tornadoes spawned by storm. Damages considered light to moderate. Only moderate build-up of tides.
Jefferson		Grande Isle suffered serious damage from storm surge and waves.		
Lafourche	Tornadoes damaged over 27 homes, 24 deaths. Heavy flooding.			
Orleans	Tornadoes / flooding	Severe damage from flood waters, wind and waves.		
Plaquemines		Storm surge up to 11.5 feet. Heavy damage from flooding.	Heaviest damages in the Venice to Buras area.	
Terrebonne				
Offshore oil rigs	Offshore and coastal installations suffered heavy damage.			
Agricultural resources				

Table 9. Hurricane Damages and Losses. *(continued)*

Location or Resource	Carmen 8/29/74	Andrew 8/16/92
Gulf coast	Flood damages in thousands ($) - 749.0 in urbanized areas; 3,052.0 for rural developed; 1,132.0 - agricultural; 189.0 - government; 144.0 - transportation; 12,000.0 - oil and natural gas. Other damages (including wind) 359.0 - government and 651.0 misc.	
Louisiana or Louisiana coastal areas		18,247 housing units damaged over a 36 parish area. Total damages estimated at over $ 1 billion in Louisiana.
Jefferson		
Lafourche		
Orleans		
Plaquemines		
Terrebonne		Some flooding caused by storm surge.
Offshore oil rigs		Total losses estimated at $250 million. 309 pipelines damaged.
Agricultural resources		Losses over $288 million.
Fisheries		Fish kill valued at $160 million. Coastal sports industry lost $12 million during Sept. and Oct., 1992. Commercial fishing industry lost - over $54 million.

Source: Bates *et al.* 1963. Source: Evangeline Economic and Planning District, 1994.
Source: U.S. Army Corps of Engineers 1972. Source: U.S. Army Corps of Engineers 1975.
Source: U.S. Department of Commerce. National Oceanic and Atmospheric Administration. 1993.

2.3. COASTAL EROSION.

Infrastructure losses as a result of coastal erosion are either immediate - following a major storm, or slow to occur. Because of this, they are not specifically documented as losses due to coastal erosion. Losses due to storm damage have previously been presented, but are not categorized as losses due to coastal erosion. No research or documents were available quantifying losses to infrastructure due to coastal erosion

Coastal erosion documentation does exist for daily conditions, and during and after the passage of major cold fronts, tropical storms, and hurricanes. Major storms are dynamic processes that produce waves and tides that erode the beach and produce a lower barrier elevation. Overall, beach erosion has resulted in a 41 percent decrease in the total area of Louisiana's barrier islands, from 98.6 km^2 in 1880 to 57.8 km^2 in 1980 (Appendix B).

The U.S. Geological Survey has archived shoreline change in Louisiana - averaging 4.2 miles per year with a standard deviation of 3.3 and a range of +3.4 to -15.3 miles per year. This is the average of conditions over a fifty year period of 600 kilometers of shoreline. Most coastal erosion in Louisiana occurs on the barrier systems that front the Mississippi River delta plain (Williams *et al.* 1992).

In Section 2.4 *Wetland Loss*, a discussion on wetland loss and its effect on infrastructure is presented. If wetland loss can be decelerated or prevented, then infrastructure will be better protected. One study suggests that barrier islands reduce wave energy, limit storm surge heights and reduce saltwater intrusion (Williams *et al.* 1992).

2.4. WETLAND LOSS

Over 40 percent of the nation's coastal wetlands are in Louisiana. Louisiana contains 55.5 percent of the northern Gulf of Mexico's coastal wetlands (Williams *et al.* 1992).

When investments in facilities, supporting service activities, and the urban infrastructure are totaled, the capital investment in the Louisiana coast adds up to more than $100 billion (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). The Louisiana coastal wetland ecosystem protects one of the largest commercial-industrial economies in the country, including deep draft ports and other navigation facilities, oil and natural gas fields, and petroleum refining industries (Boesch *et al.* 1994).

One area of concern is the impact shoreline erosion has by exposing pipelines that may be vulnerable to rupture. The pipeline network in Louisiana's coastal zone is so large, there are instances where actual ownership may be difficult to ascertain (Tabberer 1985; Wicker *et al.* 1989A and 1989B).

Approximately 60 percent to 75 percent of Louisiana's population lives within 80 km (50 mi) of the coast. The population and infrastructure have already been impacted by wetland loss and will encounter more threats as additional wetlands are lost. Loss of wetlands will increase vulnerability to storm surge, coastal flooding, and shoreline erosion. This will result in damage to homes and losses to transportation and industrial infrastructure as well as a decline in critical resources such as water supply (Day and Diffley 1993).

The current rate of coastal land loss in south Louisiana is estimated to be 6,900 hectares (17,000 acres or 27 mi^2) per year. This average was calculated using the aggregate land loss for the entire coastal plain which is primarily wetlands (Dunbar *et al.* 1992).

2.5. OIL SPILLS

2.5.1. General

Accidents happen; it is a fact of life. Even so, after an unfortunate mishap people initiate safeguards to avoid recurrence. Public, private, and corporate entities react similarly to disastrous accidents — no one benefits from any calamity. Consequently, immediately after the 1989 *Exxon Valdez* incident, Americans at all levels wanted assurances that every precaution necessary would be implemented to prevent this type of event from happening again. Conservation of natural resources, protection of wildlife and their habitats, commercial fishing industry concerns, more refined preventative measures, and a more comprehensive understanding of the behavior of oil spilled on land and/or water were highly publicized issues. Federal legislation in the form of the Oil Pollution Act of 1990 was passed that established a multiple oil spill cleanup consortium and clarified lines of responsibility in case of future oil spills. This Act became the industry's guidelines.

For the last two decades, there has been increased public awareness over the number of incidents that have resulted in many of the world's coasts being contaminated with oil. This interest intensified due to highly publicized oil spills in Prince William Sound, Alaska (*Exxon Valdez - 1989*) and the Gulf of Mexico (*Mega Borg - 1990)*. In addition, numerous small-magnitude spills have polluted wetlands in New York Harbor - (1990), Upper Delaware Bay - (1996), and areas surrounding the Houston Ship Channel - (1996). People have become increasingly conscious of the fact that oil discharged at sea causes serious environmental problems that impact the nation as a whole (Skinner and Reilly 1990). Further, oil spills can cause major short-term damages to marine and coastal environments (Van Horn *et at.* 1988; Burger 1994). Petroleum hydrocarbons at sufficient concentrations are toxic to a wide variety of marine organisms (Baldwin and Baldwin 1975; Gillman 1977; Kucklick 1994). In addition to oiling shorelines, wetlands and killing wildlife, petroleum hydrocarbons can reduce growth and alter feeding behavior (Gallaway, 1981; Van Horn *et al.* 1988; Burger, 1994; Ritchie and O'Sullivan 1994). Varied methods are used to combat oil spills, but a common lesson learned from most spills is that the best strategy is to avoid the spill in the first place. Once sizable amounts of oil are spilled into the marine environment, cleanup is difficult and costly. Mechanical spill cleanup, involving containment booms and oil recovery skimmers are the primary oil spill response methods (Interagency Coordinating Committee 1992). Dispersants also are used, where approved, although some raise concerns about their potential toxicity and about their overall effectiveness (Cahoon 1989). In general, these cleanup efforts recover less than 10 percent of the oil discharged. Of particular concern is that many of the cleanup techniques and/or activities sometimes can prove more harmful than not cleaning up the spill (Interagency Coordinating Committee 1992; Fucik *et al.* 1994)

The impact of an oil spill and the success of cleanup efforts depend on characteristics of the water and land nearby and weather conditions (Keller and Jackson 1993). In some cases, luck-good and bad- plays the prominent role in determining the severity of a spill. The shallower the water, the greater the damage likely to occur to life on the bottom. High winds and ocean currents can spread oil faster and impede cleanup efforts and tidal mud flats and shallow grass beds are especially difficult to clean. The time of day a spill occurs also can be important, as initial responses can only benefit from adequate sunlight and good visibility (Exxon, 1992). The key to an effective response plan is that "the level of pre-existing environmental and ecological information is extensive, current and easily extracted from a comprehensive data base" (Ritchie, 1995:76). Mendelssohn, Hester and Hill (1994) report on the long-term recovery rate of a Louisiana brackish marsh impacted by an oil spill in April 1985 on land loss. Their results suggest the spill did have a measurable short-term impact, but did not accelerate the long-term rate of land loss.

In assessing damages to marshes from an oil spill, research associated with the 1978 *Amoco Cadiz* spill event suggests the affected French marsh at Ile Grande has recovered from this event. Although considerable replanting was done in these marshes the extend of their influence on the recovery process has never been determined (Gundlach *et al* 1993). The ability of wetlands to exhibit long-term recovery is the focus of a number of studies (Hampson and Moul 1978; Delaune *et al.* 1979; Hershner and Lake 1980; dela Cruz *et al.* 1981; and Mendelssohn *et al.* 1990). Mendelssohn, Hester and Hill (1993) demonstrate the long-term impact of an oil spill to brackish marsh vegetation was negligible. Hoff, Shigenaka and Henry (1993) showed similar recovery rates. However, in the case of extensive, thick oil deposits, natural recovery can take decades (Baker *et al.* 1993A). Shoreline, marsh, mangrove and seagrass cleanup techniques have been carefully reviewed. The work suggests "the point at which an oiled habitat should be left alone, the most effective without increasing adverse ecological impacts" (Baker *et al.* 1993B; 588). Knowledge gaps still persists, but techniques are available to effectively clean shoreline and wetland environments (Lambert 1995).

Smaller, routine and non-accidental disposals, on land and in the water, can have a less newsworthy but equally damaging overall effect than a spill from a pipeline or oil well. These spills are, nonetheless, an important management concern. Of particular concern is the quantity of used motor oil dumped in sever drains or landfills by do-it-yourself mechanics. In this regard, it is important to note that Americans dispose of more oil from their crankcases than was spilled by the *Exxon Valdez.* Coastal barges, which carry more oil than tankers, are less regulated and can cause considerable problems (Interagency Coordinating Committee..., 1992; Von Zharen 1994). Further, offshore drilling operations can also cause coastal pollution through the disposal of wastes, although a great deal of this has been reduced recently. In fact, the northern Gulf of Mexico is one of the most developed, and impacted, areas in the world with regard to offshore oil and gas activities (McKenzie and Davis, 1994). Thus, the vulnerability of Louisiana's coast from an oil spill derived from the Outer Continental Shelf (OCS) is of great concern (Emmer *et al.*, 1992; Mendelssohn *et al.*, 1993; Henry *et al.*, 1993). In fact, of the 3,659 active production platforms located on the country's OCS in federal waters, all but 23 are in the Gulf of Mexico (Francois, 1993; U.S. Department of the Interior, 1994). Further, the oil and/or natural gas produced by these facilities is transported by pipeline to shore-based installations (U.S. Department of the Interior, 1994). The Gulf, in fact, has the world's largest network of offshore oil and gas pipelines that are responsible for transporting about 95% of OCS-derived oil and 100% of the natural gas. Each route represents a pipeline that could rupture and discharge oil along its right-of-way. In fact, between 1987 and 1991 three major pipeline breaks resulting in spills greater than 1000 barrels occurred in Federal offshore waters. Two were off Louisiana's coast: Ship Shoal Block 281 resulted in a discharge of 14,423 barrels and Eugene Island Block 314 resulted in a discharge of 4569. Both accidents occurred in 1990. The other spill was off the coast of Texas in Galveston Block A-2 (Bornholdt and Lear 1995).

Many of OCS-related pipelines use the state's barrier islands as anchor points. In addition, Louisiana's alluvial wetlands are laced with an intricate network of subaqueous pipelines that criss-cross the marshes. With time, this pipeline network has become an integral part of the nation's energy production-tens of thousands of miles of pipeline cross the coastal lowlands, often with no record of their exact location (Tabberer, 1985; Wicker *et al.*, 1989A and 1989B).

Offshore, the Minerals Management Service (MMS) has an extensive database (Table 9A) on accidents related to blowouts, general offshore spills, and vehicle collisions (Bornholdt and Lear 1995; Minerals Management Service...1995). To calculate blowouts, the MMS uses a rate of 7 blowouts per 1000 wells drilled. The historical record suggests that an oil spill will accompany 23% of all blowouts, 8% will result in spills greater than 50 barrels. Four percent will be spills in the category of 1000 barrels or greater. The duration of these blowouts is variable: 61% will last one day, 25% will last one week, and 13% will be longer than a week. Current projections suggests that between 1996 and 2030 79 blowouts will occur in the central Gulf. Most of these (719) will be less than 50 barrels. Eight will be greater than 1000 barrels and, depending on where the blowout occurs, could effect Louisiana's shoreline environments (Minerals Management Service...1995).

Table 9A. Number and volume of offshore spills greater than one barrel from Federal OCS lease facilities and operations in the Gulf of Mexico, 1987 through 1991 (adapted from Bornholdt and Lear 1995).

Year	Number of Spills		Total barrels spilled
	>1-50	>50	
1987	35	1	231
1988	30	3	15,971
1989	24	1	476
1990	35	1	19,307
1991	33	1	570
Total	157	7	36,555

MMS Statistical analysis has determined that the median size of 5600 barrels will be released from an individual pipeline accident, 7000 barrels for a platform spill, and 9200 barrels for a shuttle tanker spill. Within the central Gulf, eight spills greater or equal to 1000 barrels are projected through the year 2030. Seven hundred and fifty five spills of all sizes will occur in the next 35 years - about two a month. The majority of these accidents (719) will be less than 50 barrels. It is projected that every 37 days (345) diesel or other pollutants will be discharged into the central Gulf. Further calculation by MMS suggest, depending on a number of variables (elapsed time, barrels discharges, evaporation and others), up to 14 miles of shoreline will be affected by these various spill events. Bornholdt and Lear (1995:4-24) report that despite possible impacts, "no cumulative effects on water quality from OCS-related spills in the Gulf onshore impacts of these spill events. Therefore, since Louisiana's shoreline is the first line of defense against these spill events, it is at risk. Barrier beaches are easier to clean the wetlands. Depending on a number of variables (tidal range, type of beach material, degree of oil coating, depth of oil penetration in the soil/sand column), recovery from oil damage should begin on these shorelines within a year of the spill event (Van Horn *et al.* 1988). The barrier islands serve, therefore, two important functions: they are important staging points for cleanup operations and they represent the state's first land obstructions that will be impacted by an offshore oil spill.

Onshore there are approximately 2,500 oil and gas operators in Louisiana (U.S. Department of Energy 1994). Within the study area, there are more than 18,000 wells and an elaborate infrastructure, including pipelines and barges that are susceptible to spills (International Oil Scouts Association 1994). The *Exxon Valdez* incident demonstrated the absence of a strategy to combat shoreline -impacted oil pollution at the surface and in the subsurface. Historically, efforts have focused on containment at sea, assuming that little, if any, oil will impact the coast. A number of major spills, including the *Torrey Canyon*, *Amoco Cadiz* and *Exxon Valdez* suggest that shoreline response is of critical importance. When one considers that nearly one third of the nation's natural gas and one fourth of its oil flows through Louisiana's coastal marshes, it is clear that the industry has done a good job in preventing oil spills. Even so, the potential always exists for such an event to occur (Louisiana Oil Spill Coordinator's Office, per. com).

A total of 3,471 oil spills affecting state waters or state lands were reported to the Louisiana Oil Spill Coordinator's Office from January 1, 1994 to December 31, 1994. In 1994, the National Response Center began sending spill reports to the Oil Spill Coordinator's Office. Because of this increased cooperation, the number of reported spills increased from 305 in 1993 to more than 3,400 the following year. In fact, the parishes in the study area reported that a total of 486 (81.41%) of the reported 597 spills consisted of 10 barrels or less. The remaining 111 (18.59%) spill events were greater than 10 barrels. Nineteen spills were over 100 barrels; five ranged between 600 and 8000 barrels (Louisiana Oil Spill Coordinator's Office, per. com.). Most of these spills are related to some form of mechanical problem or human error and, in general, average less than five barrels per spill. barrels (Louisiana Oil Spill Coordinator's Office, per. com.).

In coastal Louisiana, approximately 250,000 gallons (nearly 6,000 barrels) of waste oil are generated by the state's commercial fishing industry, representing more than 50,000 disposal events annually. If this is not discarded properly, it has the potential of impacting coastal ecosystems (Adams 1995). Small, routine and non-accidental disposals, on land and in the water can have a less newsworthy but equally damaging environmental effect. Consequently, these small spills collectively add up, particularly when coupled with the 486 spill of 10 barrels or less reported in 1994 within the study area (Louisiana Oil Spill Coordinator's Office, pers. com.). Besides the environmental risks associated with these small to much larger spill events, there are other problems. These include fouling of recreational and park beaches, fouling of recreational, commercial fishing, and pleasure boats, fouling of water intake pipes, water lines, industrial complexes, docks, and piers.

In the wetlands, damage from an oil spill is assessed through the Natural Resource Damage Assessment (NRDA) process as required by the Comprehensive Environmental Response, Compensation and Liability Act. The process is designed to "restore natural resources and services injured as a result of an incident involving oil" (Department of Commerce 1996, p. 440). In the final rules it is clear that the intent is to assess the extent of injury to natural resources and services. In this case, *injury* is defined as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service" (Department of Commerce 1996, p. 441). There is no mention of infrastructure loss from an oil spill caused by natural processes (U.S. Department of the Interior 1993).

Appendix C presents oil spills which have occurred within the study area between 1993 and 1995. The majority of these spills impacted waterbodies. The causes for the spills are varied. Many occurred during the transfer of the oil: from tankers, through pipelines, and from tank trucks.

Oil spill losses are generally calculated as the value of product lost and the cost of cleaning the spill up. Research has shown that losses to infrastructure as a result of these oil spills are not quantified. The resulting pollution to the water environment and its adverse impacts on natural resources, wildlife and their habitats, and the commercial fishing industry, however, is also not quantified. Therefore, a realistic method of assessing oil spills has yet to be devised.

2.5.2. Greenhill Petroleum Company's Well No. 250 Spill in Timbalier Bay - Case Study.

On September 29, 1992, natural gas and petroleum Well No. 250 in Timbalier Bay, began discharging crude oil and natural gas as a result of loss of well control during workover operations. Greenhill promptly initiated response actions to contain and remove the spilled oil. While attempting to cap the well on October 1, 1992, the oil and natural gas ignited. The blowout resulted in a discharge of approximately 96,000 gallons of oil into the Timbalier Bay estuarine environment. The concentration and quantity of oil discharged impacted, to varying degrees, approximately 49 ha (122 acres) of intertidal marshes on East Timbalier, Timbalier, Brush, Calumet, and Casse-tete Islands.

Under the Oil Pollution Act and Comprehensive Environmental Response, Compensation and Liability Acts natural resource trustees are authorized to recover funds (damages) sufficient to restore or replace natural resources injured as a result of a discharge of oil into navigable waters of the United States and adjoining shoreline. The resultant Greenhill settlement was atypical since the natural resource trustees and Greenhill agreed to an in-kind restoration project, rather than pursuing monetary compensation for natural resource injuries. The company agreed to create 9 ha (21.7 acres) of planted Spartina alterniflora marsh on East Timbalier Island that would have 80 percent vegetative coverage at the 2-year mark following completion of planting. In addition, the company agreed to monitor the created marsh for five (5) years, beginning after completion of the initial planting, to determine whether the restoration of marsh habitat was achieved (Louisiana Oil Spill...1995).

3.0 SUSCEPTIBILITY OF STRUCTURES AND FACILITIES TO LOSS AND DAMAGE

The quantitative assessment of the susceptibility of the structures and facilities inventoried to loss or damage from hurricane/storm induced floods, oil spills, wave activity, wetland/loss and shoreline erosion is addressed in this chapter. The assessment of susceptibility is based on previous damage and loss reports which were reviewed to identify the magnitude of damages and losses by type of economic resource impacted, causal sources, and the geographic location where damages and losses were sustained.

The area susceptible to damage and loss is defined as the zone of economic analysis exclusive of areas within hurricane protection levees. The initial delineation of the zone of economic analysis was made based on hurricane surge inundation exclusive of backwater flooding or flooding due to excessive precipitation. Starting at the study area shoreline, the zone of economic analysis was delineated as being the northern-most point where water driven by a 100-year event hurricane surge would reach. Data contained in the report entitled *Water Level Statistics for Design of Transportation Facilities in Coastal Louisiana* were used to establish the boundary (Suhayda and Alawady 1993). The zone of economic analysis has been revised to exclude areas protected by levees as presented in the report entitled *Southeast Louisiana Hurricane Preparedness Study* (U.S. Army Corps of Engineers 1994).

Research has been presented in this report of damage and loss to human-made infrastructure due to the causal sources of hurricane/storm induced floods, oil spills, wave activity, wetland/loss and shoreline erosion were reviewed. Based on the previous research, the susceptibility of human-made capital economic resources to loss and damage from storm/hurricane surge-induced flooding appears to be directly related to geographic proximity to large bodies of open water and the Louisiana coastline. The review of previous research uncovered no documentation of susceptibility of structures and facilities quantifying loss or damage from oil spills, wave activity, wetland/land loss or shoreline erosion.

The review findings indicate documentation for formulating a quantitative assessment of susceptibility is lacking since: 1) damage and loss to infrastructure is generally not presented by causal source, and 2) the value of damage and loss estimates are not prepared with a consistent or standardized methodology and are of questionable reliability.

The losses presented in Section 2.0 are not clearly designated by causal source, making it difficult to differentiate between wind- and water-induced losses. Also, as illustrated by the descriptions of each hurricane, circumstances vary from a Category 1 hurricane with wind speeds over 75 miles per hour and a storm surge over 3.94 feet (see Appendix L - Saffir-Simpson Scale of Damage Potential) causing minimal damage, to a Category 5 with wind speeds over 155 miles per hour and a storm surge over 17.7 feet, causing catastrophic damage. The location the hurricane makes landfall, as well as the rainfall generated, also determine the magnitude of damage to an area.

An evaluation of susceptibility to loss from hurricane-induced flooding may be made based on research of previous damages. The susceptibility from other causal sources, however is more difficult to assess due to a lack of documented losses as a result of these causal sources.

An estimated \$3.672 billion in human-made capital economic resources are susceptible to damage or loss from hurricane/storm surge in the four coastal parishes within the zone of economic analysis (Table 10). The estimate is based on select economic resources (e.g., residential units, oil and gas wells, schools, roads and railroads) which could be geographically identified by point location or census block group using inventory data.

Table 10. Selected Economic Resources Susceptible to Loss from Storm Surge.

Economic Resources	Jefferson	Lafourche	Plaquemines	Terrebonne	Total
Units					
Residential Occupied	2,709	1,721	4,731	16,175	25,336
Residential Vacant	1,737	105	930	2,162	4,934
Commercial Structures	*	*	*	*	*
Oil and Gas (wells)	1,119	2,885	1,293	3,993	9,290
Farms - Land and Buildings	*	*	*	*	*
Schools (sq. feet)	51,590	6,790	99,995	169,785	328,160
Highways/Roads/Bridges (miles)	98.2	218.8	335.5	620.15	1272.7
Railroads (miles)	0.0	0.4	44.0	17.5	61.9
Value (\$ Millions - 1995)					
Residential Occupied	171.41	169.77	280.80	911.31	1793.94
Residential Vacant	116.88	16.03	56.75	105.77	345.65
Commercial Structures	*	*	*	*	*
Oil and Gas	40.60	198.54	65.61	216.13	552.14
Farms - Land and Buildings	*	*	*	*	*
Schools	4.10	0.50	8.00	13.60	26.20
Highways/Roads/Bridges	73.70	164.10	251.60	465.10	954.50
Railroads	0.00	0.00	0.23	0.05	0.30
Total Values	406.69	548.93	662.99	1,711.97	3,672.73

Source: U.S. Department of Commerce. 1992 (a).
Source: U.S. Department of Commerce. 1991.
Source: Louisiana Tax Commission. 1994
Source: Louisiana Department of Transportation and Development. 1996.
Source: Louisiana Department of Education. 1991.
Source: Come 1996.
Source: Louisiana State Legislature. The Children First Act. No. 659. 1988.
Source: Bureau of Labor Statistics. 1996.
* - Data not available by Block Group.

Commercial structures are known to exist within the zone of economic analysis, however, valuation estimates were not compiled since the inventory was based on parish level data. Retail trade and service businesses are located in the communities within the zone of economic analysis. Supply bases for outer continental shelf oil and gas activities in the Gulf of Mexico are located in Venice, Grand Isle, Port Fourchon, Leeville, Golden Meadow, Cocodrie and Dulac (U.S. Dept. of the Interior 1989). All materials and supplies used in offshore oil and gas operations are transported through supply bases. Boat docks, heliports, warehouses, storage yards, parking lots and office buildings are typical structures and facilities present at supply bases (McKenzie and Davis 1994). Although these commercial structures exist, no data were available to prepare an estimate of potential for damage and loss due to hurricane/storm-induced surge.

Although the number and value of farms (land and buildings) could not be estimated since inventory data were at the parish level, the extent of farming within the zone of economic analysis is limited by soil conditions. Farming operations in the study area are generally limited to soils associated with natural levees and backswamp borders which, by virtue of topography, are excluded from the zone of economic analysis (Touchet 1995).

4.0 INVENTORY OF ECONOMIC RESOURCES

The inventory of economic resources includes three categories of infrastructure: 1) private residential, commercial and industrial structures and facilities; 2) farmland and agricultural resources; and 3) public resources. This inventory is based on available secondary data. Some data, such as residential structures (Census housing units) are presented in great geographic detail by block groups within the study area. All other data are presented by parish.

Each element of the inventory is introduced by an explanation of the data collected, its source, and any definitions as necessary to explain the tables that follow. These economic resources represent the most significant structures and facilities within the study area.

4.1. RESIDENTIAL STRUCTURES.

An inventory of residential structures was collected for the eleven parish area by block group within the study area from the 1990 Census of Housing for Louisiana. This included total housing units, occupied housing units and vacant housing units. A complete accounting of these housing units is presented in Appendix D. The definition of each of these is as follows:

1. *Total Housing Units* - A housing unit is a house, an apartment, a mobile home or trailer, a group of rooms or a single room occupied as separate living quarters or,

if vacant, intended for occupancy as separate living quarters. Separate living quarters are those in which the occupants live and eat separately from any other persons in the building and which have direct access from outside the building or through a common hall (U.S. Department of Commerce 1993).

2. *Occupied Housing Units* - A housing unit is classified as occupied if it is the usual place of residence of the person or group of persons living in it at the time of enumeration, or if the occupants are only temporarily absent; that is, away on vacation or business (U.S. Department of Commerce 1993).

3. *Vacant Housing Units* - A housing unit is vacant if no one is living in it at the time of enumeration, unless its occupants are only temporarily absent. New units not yet occupied are classified as vacant housing units if construction has reached a point where all exterior windows and doors are installed and final usable floors are in place. Vacant units are excluded if they are open to the elements; that is, the roof, walls, windows, and/or doors no longer protect the interior from the elements, or if there is positive evidence (such as a sign on the house or in the block) that the unit is condemned or is to be demolished. Also excluded are quarters being used entirely for nonresidential purposes, such as a store or office, or quarters used for storage of business supplies or inventory, machinery or agricultural products (U.S. Department of Commerce 1993).

Table 11. Residential Structures in the Study Area - Summary.

Parish	Total Housing Units	Occupied Housing	Vacant Housing
Ascension	21,165	19,337	1,828
Assumption	8,644	7,397	1,247
Jefferson	72,877	63,088	9,789
Lafourche	31,332	28,835	2,497
Orleans	23,444	19,582	3,862
Plaquemines	8,561	7,455	1,106
St. Charles	7,843	6,946	897
St. James	2,931	2,749	182
St. John	1,321	1,114	207
St. Mary	6,934	6,164	770
Terrebonne	35,416	31,837	3,579
Totals	220,468	194,504	25,964

Source: U.S. Department of Commerce. Bureau of the Census. 1992.

4.2. COMMERCIAL STRUCTURES AND FACILITIES.

The inventory of commercial structures and facilities was compiled *from County Business Patterns 1990* for Louisiana. The data presented is by parish and includes the total number of establishments, annual employment, and payroll amounts annually and by quarter (see Appendix E). The data is tabulated by industry as defined in the *Standard Industrial Classification (SIC) Manual: 1987* (U.S. Department of Commerce 1992b). The economic divisions represented cover most of the area's economy, including: agricultural services, mining, construction, manufacturing, transportation, public utilities, wholesale trade, retail trade, finance, insurance, real estate, and services. This data depicts the types of employment covered by the Federal Insurance Contributions Act (FICA). Data for employees of establishments totally exempt from FICA are excluded, as are self-employed persons, domestic service workers, railroad employees, agricultural production workers, most government employees, and employees on oceanborne vessels or in foreign countries (U.S. Department of Commerce 1992b).

The definition of each of the data elements is as follows:

1. *Establishment* - a single physical location at which business is conducted or where services or industrial operations are performed. All activities carried on at this location are grouped together and classified on the basis of the major reported activity, and all data for the establishment are included in that activity. Establishment counts represent the number of locations determined to be active anytime during the year (U.S. Department of Commerce 1992b).

2. *Employment* - paid full- and part-time employees, including salaried officers and executives of corporations, who were on the payroll in the pay period including March 12. Included are employees on paid sick leave, holidays, and vacations; not included are proprietors and partners of unincorporated businesses (U.S. Department of Commerce 1992 b).

3. *Total annual payroll* - all forms of compensation, such as, salaries, wages, commissions, bonuses, vacation allowances, sick-leave pay, and the value of payments inkind (free meals and lodging) paid during the year to all employees. Tips and gratuities received by employees and reported to employers are included. For corporations, it includes payment to officers and executives; for unincorporated businesses, it does not include profit or other compensation of proprietors or partners.

Payroll is reported before deductions for social security, income tax, insurance, union dues, etc. First quarter payroll consists of payroll paid to persons employed at any time during the January to March quarter (U.S. Department of Commerce 1992b).

The number of establishments was used to represent commercial structures within the study area. Due to the SIC classification system used, these establishments include industrial type businesses within the study area. **Part 4.3. Industrial Structures and Facilities**, encompasses only oil-related businesses and port facilities as specified in the scope of work.

Table 12. Commercial Establishments - Summary.

Major Group	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines
Agricultural Service., forestry, & fishing	8	0	87	31	56	16
Mining	6	3	80	19	96	49
Construction	101	17	894	109	426	52
Manufacturing	72	9	388	55	341	42
Transportation & public utilities	58	12	495	217	506	121
Wholesale trade	77	15	1,215	106	734	87
Retail trade	298	72	2,865	425	2,817	131
Finance, insurance & real estate	78	17	1,062	132	1,051	35
Services	303	61	4,101	444	4,549	169
Unclassified establishments	28	6	372	60	407	27
Totals	1,029	212	11,559	1,598	10,983	729

Major Group	St. Charles	St. James	St. John	St. Mary	Terrebonne
Agricultural Service., forestry, & fishing	6	1	10	13	25
Mining	5	1	2	50	88
Construction	49	24	40	93	131
Manufacturing	29	28	24	73	122
Transportation & public utilities	50	26	39	126	123
Wholesale trade	55	19	41	107	225
Retail trade	143	82	131	351	591
Finance, insurance & real estate	38	27	48	105	190
Services	181	81	173	407	678
Unclassified establishments	21	5	26	44	78
Totals	577	294	534	1,369	2,251

Source: U.S. Department of Commerce. 1992 (b).

4.3. INDUSTRIAL STRUCTURES AND FACILITIES.

4.3.1 Background

On shore within the study area there are numerous production and/or ancillary features; however, no accurate inventory currently exists of these facilities. The Oil Spill Coordinator's Office has funded a study, in progress, that will, when completed, provide an accurate assessment of the onshore oil and gas industry in coastal Louisiana.

4.3.2. Oil and Gas Fields

The material presented in Appendix F clearly indicates that 38 oil and gas fields are more than 50 years old and perhaps have reached the end of their usefulness. There are 10,345 wells in these fields. Therefore, their infrastructure is a bit weather-worn, predates environmental concerns and regulations, and are designed to maximize oil and gas production not necessarily to meet the engineering criteria associated with open-water conditions. Preventive maintenance is expensive and, in a period of declining revenue, often delayed. In addition, the 38 fields illustrated in Table 13 were designed to operate in shallow estuarine waters. They were never intended to survive in open Gulf conditions. Nevertheless, within the study area there are 342 oil and gas fields representing 18,901 oil and gas wells. In the five parishes immediately adjacent to the barrier islands (Jefferson, Lafourche, Plaquemines, St. Mary, and Terrebonne) there are 270 fields (78.9 percent of the total) involving 17,320 (91.6 percent of the total) oil and gas wells (International Oil Scouts Association 1994) (Table 13).

Table 13. **Industrial Structures: Oil and Gas Fields - Summary.**

Parish	Field Names	Date of Discovery	Number of Wells
Ascension			
	Darrow	1932	133
	Sorrento	1928	57
Assumption			
Jefferson			
	Barataria	1939	49
	Lafitte	1936	479
Lafourche			
	Bayou des Allemands	1937	129
	Chacahoula	1938	167
	Golden Meadow	1938	818
	Lafourche Crossing	1939	19
	Lake Long	1937	45
	Leeville	1931	445
	Raceland	1936	78
	Timbalier Bay Onshore	1939	590
	Valentine	1936	205
Orleans			
Plaquemines			
	Garden Island Bay	1934	762
	Grand Bay	1938	390
	Lake Hermitage	1934	38
	Lake Washington	1931	583
	Potash	1937	93
	Quarantine Bay	1937	306
	Venice	1937	283
St. Charles			
	Paradis	1939	266
St. James			
	La Pice	1939	79
	Vacherie	1938	34
St. John the Baptist			
	La Place	1939	13
St. Mary			
	Bateman Lake	1937	205
	Charenton	1936	1152
	Horseshoe Bayou	1937	68
	Jeanerette	1935	186

Terrebonne			
	Bay Baptiste	1938	19
	Caillou Island	1930	1248
	Delarge	1938	11
	Dog Lake	1929	284
	Four Isle Dome	1935	76
	Gibson	1937	116
	Houma South	1938	11
	Lake Barre	1929	512
	Lake Pelto	1929	323
	Lirette	1937	73
Totals		38	10,345

Source: International Oil Scouts Association.1994.

Should the barrier island complex deteriorate completely, certain wetland fields will be subject to wave and energy conditions beyond their design limits. If they cannot survive these increased energy conditions, it is time to retrofit those fields to withstand open Gulf conditions. As stated, there are 18,901 wells within the 11-parish study area (International Oil Scouts Association 1994). Some are more vulnerable than others, but all will be influenced directly or indirectly from a Category 4 or 5 hurricane making landfall within the region, particularly if the winds are sustained inland (Table 13).

4.3.3. Oil and Gas Refineries

There are five active refineries located within or near the study area. Information is provided regarding operating capacity as of June 30,1994, idle capacity, and operating rate as a percent of total operating capacity.

Table 14. Industrial Structures: Oil and Gas Refineries.

Refinery Name	Parish	City	Operating Capacity bbl/day	Idle Capacity bbl/day	Operating Rate %
B. P. Oil Co./Alliance Refinery	Plaquemines	Belle Chasse	222,764	7,236	88.6
Marathon Oil Company	St. John	Garyville	255,000	0	79.9
St. Rose Refining Company	St. Charles	St. Rose	32,400	7,600	81.0
Shell Oil Company	St. Charles	Norco	215,000	0	98.9
Star Enterprise	St. James	Convent	225,000	0	92.7

Source: Louisiana Department of Natural Resources. Technology Assessment Division 1995.

4.3.4. Gas Processing Plants

Forty-five percent of the gas processing plants in Louisiana are located in coastal parishes (Wicker *et al.* 1989). Table 15 lists the plants located in the study area by parish and city.

Table 15. Industrial Structures: Gas Processing Plants.

Plant Name	Parish	City	(MMcfd)	(MMcfd) 1984
Amoco Production Co.	Lafourche	Raceland	85	16
Celeron	Terrebonne	Gibson	90	90
Cities Service Company	St. James	St. James	38	18
Exxon Corp.	Jefferson	Grand Isle	100	57
Exxon Corp.	Lafourche	Thibodaux	45	17
Liquid Products Recovery 1	Assumption	Napoleonville	15	1
Liquid Products Recovery 2	Assumption	Napoleonville	8	1
Louisiana Land and Exploration Co.	Terrebonne	Houma	125	30
Mobil Oil Corp.	Lafourche	Golden Meadow	125	75
Phillips Petroleum Co.	Lafourche	Valentine	16	11
Placid Oil Company	Terrebonne	Chauvin	100	19
Shell Oil Company	St. Charles	Hahnville	120	50
Shell Oil Company	Terrebonne	Gibson	1400	722
Shell Oil Company	Terrebonne	Chauvin	100	18
Superior Oil Company	Terrebonne	Dulac	50	46
Texaco Inc.	St. Charles	Paradis	860	300
Texaco Inc.	Terrebonne	Cocodrie	11	8
Texaco Producing Inc.	Plaquemines	Venice	65	31
Texaco Producing Inc.	Plaquemines	Buras	150	0
Texaco Producing Inc.	Terrebonne	Houma	150	30
Union Oil Company of California	Terrebonne	Houma	120	20
Warren Petroleum Co.	Plaquemines		819	430

Source: Wicker *et al.* 1989.
MMcfd = Million cubic feet per day.

4.3.5. Pipelines

Pipelines are an inexpensive, efficient, transportation system. These routes provide the nation the feed stock necessary to meet commercial and residential demands. Consequently, there has developed with time an intricate web of pipelines connecting the source of supply to the market. These pipelines guarantee their users can maintain production levels to insure their markets are not without their respective products.

Canal and pipeline rights-of-way represent a maze of tributary lines that coalesce into an integrated, complex network of transport arteries (Davis 1992). Louisiana's alluvial wetlands are, therefore, laced with canals and subaqueous pipelines (Tabberer 1985; Wicker *et al.* 1989A and 1989B). This pipeline network has become an integral part of the nation's energy production—tens of thousands of miles of pipeline cross the coastal lowlands, often with no record of their exact location. Many are anchored to the state's barrier island complex.

Of the 164 Federal Outer Continental Shelf (OCS) pipelines constructed between 1950 and 1986, 70 percent cross barrier island complexes or beaches and 30 percent make landfall along marshy shorelines (Wicker *et al.* 1989). Table 16 presents the Outer Continental Shelf pipelines which make landfall within the study area. The CEI No. is a number assigned by Coastal Environments, Inc. to identify each pipeline on the associated maps. The Lease Block Origin abbreviations used are: EI - Eugene Island, SM - South Marsh Island, SS - Ship Shoal, ST - South Timbalier, BM - Bay Marchand, GI - Grand Isle, and WD - West Delta.

Table 16. Industrial Structures: Pipelines.

CEI NO.	Owner/Operator	Origin	USGS Quad Landfall	Size	Contents	Date
L54	American Natural Resources	EI199	Lake Salve, LA	20"	Gas	1965
L55	American Natural Resources	EI63	Lake Salve, LA	30"	Gas	1968
L56	Trunkline Gas Company	SM268	Lake Salve, LA	22"	Gas	1979
L57	Transco Gas Pipeline Co.	EI129	Oyster Bayou, LA	24"	Gas	1967
L58	Transco Gas Pipeline Co.	EI129	Oyster Bayou, LA	20"	Gas	1962
L59	Transco Gas Pipeline Co.	EI129	Oyster Bayou, LA	16"	Gas	1963
L60	Transco Gas Pipeline Co.	SS28	Oyster Bayou, LA	16"	Gas	1961
L61	Transco Gas Pipeline Co.	SS28	Oyster Bayou, LA	20"	Gas	1967
L62	Shell Pipeline Corporation	SS28	East Bay Junop, LA	16"	Gas	1966
L63	Shell Pipeline Corporation	SS28	East Bay Junop, LA	22"	Oil	1967
L64	Trunkline Gas Company	SS139	Point Aux Fer NE, LA	30"	Gas	1968
L65	Trunkline Gas Company	SS139	East Bay Junop, LA	30"	Gas	1981
L66	Tex. Gas Transm. Corp.	SS26	East Bay Junop, LA	4"	Gas	1968
L67	Tex. Gas Transm. Corp.	SS26	East Bay Junop, LA	16"	Gas	1969
L68	Transco Gas Pipeline Co.	SS214	W. Isl. Dernieres, LA	26"	Gas	1969
L69	Tennessee Gas Pipeline Co.	SS198	C. Isl. Dernieres, LA	26"	Gas	1969
L70	Tenn. Gas (Columbia Gulf)	SS198	C. Isl. Dernieres, LA	36"	Gas	1976
L71	Odeco	SS113	C. Isl. Dernieres, LA	8"	Oil	1970
L72	Tex. Pipeline Company	SM128	Cat Isl. Pass, LA	20"	Oil	1976
L73	Gulf Oil Company	ST35	Calumet Isl., LA	12"	Gas	1978
L74	Gulf Oil Company	ST35	Calumet Isl., LA	16"	Oil	1978
L75	Tenn. Gas Pipeline Company	ST37	Calumet Isl., LA	20"	Gas	1977
L76	Gulf Oil Company	ST37	Calumet Isl., LA	24"	Gas/Oil	1976
L77	Gulf Oil Company	ST21	Calumet Isl., LA	10"	Oil	?
L78	Gulf Oil Company	ST21	Calumet Isl., LA	10"	Oil	1978
L79	Gulf Oil Company	ST21	Calumet Isl., LA	14"	Gas	1978
L80	Gulf Oil Company	ST21	Calumet Isl., LA	6"	Gas	?
L81	Gulf Oil Company	ST21	Calumet Isl., LA	10"	Gas/Oil	n.d.
L82	United Gas Pipeline Co.	ST26	Belle Pass, LA	12"	Gas	1972
L83	Tenn. Gas Pipeline Company	BM5	Belle Pass, LA	12"	Gas	?
L84	Gulf Oil Company	ST21	Calumet Isl., LA	6"	Oil	?
L85	Tenn. Gas Pipeline Company	ST55	Belle Pass, LA	16"	Gas	1968
L86	Tenn. Gas Pipeline Company	ST21	Belle Pass, LA	16"	Gas	1961
L87	Tenneco Oil Company	BM22	Belle Pass, LA	6"	Gas	Pre 1973
L88	Chevron USA	ST63	Belle Pass, LA	10"	Oil	1969
L89	Gulf Refining Company	ST130	Belle Pass, LA	12"	Oil	1976
L90	Gulf Refining Company	ST130	Belle Pass, LA	18"	Oil	Pre 1966
L91	Shell Pipeline Corporation	ST26	Belle Pass, LA	6"	Oil	1966
L92	Gulf Oil Company	GI37	Belle Pass, LA	10"	Oil	1960
L93	Gulf Oil Company	GI37	Belle Pass, LA	10"	Oil	1958
L94	Chevron USA	?	Belle Pass, LA	10"	Oil	?
L95	Exxon USA	GI22	Grand Isle - Bara. Pass, LA	16"	Gas	1964
L96	Exxon USA	GI22	Grand Isle - Bara. Pass, LA	12"	Gas	1970

Table 16. Industrial Structures: Pipelines. *(continued)*

CEI NO.	Owner/Operator	Origin	USGS Quad Landfall	Size	Contents	Date
L97	Conoco, Inc.	GI47	Caminada Pass, LA	12"	Oil	1957
L98	Exxon Pipeline Company	WD73	Grand Isle - Bara. Pass, LA	12"	Oil	1978
L99	Exxon Pipeline Company	WD73	Grand Isle - Bara. Pass, LA	12"	Oil	1963
L100	Exxon Pipeline Company	WD73	Grand Isle - Bara. Pass, LA	12"	Oil	1986
L101	Conoco, Inc.	GI43	Grand Isle - Bara. Pass, LA	16"	Oil	1968
L102	Exxon USA	GI22	Barataria Pass, LA	10"	Gas	1958
L103	Tenn. Gas Pipeline Company	GI43	Bastian Bay, LA	24"	Gas	1973
L104	Tenn. Gas Pipeline Company	GI43	Bastian Bay, LA	20"	Gas	1959
L105	Southern Natural Gas	WD133	Bastian Bay, LA	8"	Gas	1967
L106	Southern Natural Gas	WD29	Bastian Bay, LA	12"	Gas	1963
L107	Tenn. Gas Pipeline Company	WD31	Bastian Bay, LA	12"	Gas	1966
L108	Shell Pipeline Company	WD32	Buras, LA	12"	Oil	1965
L109	Exxon USA	WD30	Buras, LA	10"	Oil	1956
L110	Chevron USA	WD26	Buras, LA	6"	Oil	1955
L111	Chevron USA	WD29	Buras, LA	6"	Oil	1955
L112	Gulf Oil Company	WD41	Pass Tante Phine, LA	26"	Gas/Oil	1965

Source: Wicker *et al.* 1989.

4.4. PORT FACILITIES

Port facilities are an important supply/service base for the offshore oil industry. Many were specifically developed to service this industry, while others have expanded as offshore demands grew during the 1960s and 1970s (Wicker *et al.* 1989). There are six industrial port facilities within the study area, each providing a variety of services, import and export opportunities. The following tables briefly describe these port facilities.

Table 17. Port Fourchon.

Location:	From the Intracoastal south to the Gulf of Mexico in Lafourche Parish.
Port Type:	Shallow draft 20 feet in main channel, 20 feet along side.
Major Commodities:	**Import**: Beef, Limestone, Fruit, Vegetables **Export**: Rice, Resin, Cotton, Aluminum
Foreign Trade Zone:	None
Port Services:	**Pilot Associations** - available upon request. **Customs House Brokers** - N/A **Freight Forwarders** - N/A **Stevedores** - Fourchon Quick Repair, Inc.; Danos and Curole Marine.
Transportation:	**Airport** - Nearest general passenger or commercial service - New Orleans International Airport. **Railroads** - Southern Pacific **Truck Lines** - Acme, Ace, Venture, Dynasty **Steamship Lines and Agents** - Navios Ship Agencies, Transoceanic, Central Dispatch, Deepwater Port Services **Tank Farm** - Chevron Tank Farm, Texaco **Ship and Barge Repair** - Rae Shipyard, North American Shipyard, Superior Shipyard, Lafourche Shipyard, Nolty Theriot, Inc., Bollinger Shipyard, Allied Shipyard **Barge Lines** - L & MBO Truck Rentals, Inc., Crosby Boat Company, D & C Marine Contractors, Inc., Montco, Inc., Doucet and Adams, Inc. **Barge Fleeting Operation** - Crosby Boat Company, United Tugs, Inc., Huey L. Cheramie, Inc., Tidewater Dock, Tug Nah, Inc., Louisiana Tugs **Shipping Lines** - None **Towing and Tug Services** - offered by 40 companies
Oil and Gas Services:	N.L. Baroid, Nolty Theriot, Inc., L & L Oil Company, M-I Drilling Fluids, Ambar, Air Logistics, ERA Aviation, Tri-State Oil Tools, Milpark, Martin Fuel Dist., Stone Petroleum, Halliburton, New Park Environmental Services, B. J. Titan, PHI, Campbell Well Service, Evergreen Helicopters, Rowan Drill.

Source: Louisiana Department of Transportation and Development 1994a.

Table 18. Port of South Louisiana.

Location:	River mile 114.9 and end at 168.5 between New Orleans and Baton Rouge.
Port Type:	Deep draft 45 feet in main channel, 50 feet along side.
Major Commodities:	**Import**: Crude Oil, Aluminum Ores, Non-Crude Oil, Sugars, Crude Minerals, Propane/Butane, Pig Iron, Fixed Vegetable Fats and Oils, Fertilizers, Petroleum Products, Chemicals, Iron, Steel, Lime, Base Metal Ores, Ferrous Scrap, Sand and Gravel **Export**: Corn, Animal Feed, Soybeans, Wheat, Cereals, Petroleum Products, Rice, Fixed Vegetable Fats and Oils, Chemicals, Coal, Iron and Steel Forms, Animal Oils and Fats, Wood Chips, Vegetables - Tubers, Non Electric Parts.
Foreign Trade Zone:	#124 (4 sites) - Star Enterprise, Marathon Oil Refinery, Trans American Refinery, North American Shipbuilding
Port Services:	**Pilot Associations** - 3 Pilot Associations, Federal Coastal Pilots Group. **Customs House Brokers** - Bob Hanks **Freight Forwarders** - 77 Forwarding Companies **Stevedores** - 15 Stevedoring Companies
Transportation:	**Airport** - Nearest general passenger or commercial service - New Orleans International Airport. **Railroads** - Southern Pacific, Kansas City Southern, Illinois Central, Union Pacific **Truck Lines** - 57 Common Carriers, 18 Container Haulers, 51 Drayage Companies, 22 Heavy Haulers, 10 Refrigerated **Steamship Lines and Agents** - 71 Steamship Lines **Tank Farm** - 3 Tank Farms **Ship and Barge Repair** - 19 Companies **Barge Lines** - 81 Barge Lines **Barge Fleeting Operation** - 51 Fleeting Companies **Shipping Lines** - 70 Steamship Lines **Towing and Tug Services** - offered by 12 companies
Oil and Gas Services:	None listed.

Source: Louisiana Department of Transportation and Development 1994a.

Table 19. Plaquemines Parish Port.

Location:	Mile point 82 to the Gulf of Mexico.
Port Type:	Deep draft 45 feet in main channel, 90 feet along side, 45 feet in Southwest Pass.
Major Commodities:	**Import**: Steel **Export**: Coal, Coke, Soybean, Corn, Wheat **Domestic**: Crude Oil, Phosphate, Coal
Foreign Trade Zone:	None
Port Services:	**Pilot Associations** - Associated Branch Pilots, New Orleans/Baton Rouge Pilots Association, Crescent River Port Pilots Association. **Customs House Brokers** - N/A **Freight Forwarders** - N/A **Stevedores** - Cooper T. Smith, Ryan Walsh
Transportation:	**Airport** - Nearest general passenger or commercial service - New Orleans International Airport. **Railroads** - Missouri Pacific, Union Pacific, Norfolk Southern **Truck Lines** - Arkansas Freightways, Inc., Roadway Express, Inc. **Steamship Lines and Agents** - 21 Steamship Lines **Tank Farm** - N/A **Ship and Barge Repair** - N/A **Barge Lines** - 28 Barge Lines **Barge Fleeting Operation** - N/A **Shipping Lines** - N/A **Towing and Tug Services** - N/A
Oil and Gas Services:	None listed.

Source: Louisiana Department of Transportation and Development 1994a.

Table 20. Port of West St. Mary.

Location:	River Mile Marker 133 on Gulf Intracoastal Waterway.
Port Type:	Shallow draft 14 feet in main channel, 14 feet along side.
Major Commodities:	**Import**: Resins, Cement and Sand, Peppers, Steel, Wood Products **Export**: Metal Fabrications, Building Materials, Construction Equipment, Vehicles, Agricultural Equipment
Foreign Trade Zone:	None
Port Services:	**Pilot Associations** - N/A **Customs House Brokers** - Worldwide Services, Inc.; David Mulhern; Transcontainer Transport, Inc.; Carol Worley, DSL, Houston, Texas **Freight Forwarders** - Same as Custom Brokers **Stevedores** - Paul Laine & Co.; Twin Brothers Marine, Inc.; Superior Services, Inc.; Barclay Chemical, Inc.; Cargill, Inc.; Branch Warehousing
Transportation:	**Airport** - Nearest general passenger or commercial service - Lafayette Regional Airport, Patterson - General Aviation, Acadiana Regional-General Aviation, Jeanerette - General Aviation **Railroads** - Southern Pacific, LA and Delta **Truck Lines** - SAIA, Yellow Freight, MS Carriers, JB Hunt, Davis, Arkansas Freight **Steamship Lines and Agents** - Charters (Port Royal), Meridian Shipping, Worldwide Services, David Mulhern **Tank Farm** - N/A **Ship and Barge Repair** - Twin Brothers Marine, Dual Fabricators, Inc., Superior Fabricators, Inc., Douglas Marine, Inc. **Barge Lines** - ACBL, Compass Marine, Canal, Dixie, Hollywood, Creole, National Marine, Ingram, Bundy, Inc. Barge Fleeting Operation - Carey Salt, Morton Salt, Douglass Marine, Inc. **Shipping Lines** - N/A **Towing and Tug Services** - Raymond Offshore, Paul Laine & Co., Douglass Marine, LeBoeuf Towing, Canal Barge & Towing, Compass Marine, National Marine
Oil and Gas Services:	None listed.
Public Facilities:	1,500 foot Concrete/Steel Dock Bulkhead; Four Railspurs; Public Warehouses and Docks; Crane Services; Stevedoring Services, Certified Tractor/Trailer/Rail Car Scale; Roro Facilities; Dry Bulk Cargo Facilities; General Cargo Facilities; Container Storage; Reefer Box Connections; Heavy Industrial Sites; Seafood Pickup Stations; and Ship Side Transit Sheds.

Source: Louisiana Department of Transportation and Development 1994

Table 21. Port of New Orleans.

Location:	Over 22 miles of waterfront along the Mississippi River and the Industrial Canal/Mississippi River Gulf Outlet Area.
Port Type:	Deep draft 45 feet in main river channel, 36 feet in Mississippi River Gulf Outlet.
Major Commodities:	**Import**: Petroleum Products, Iron, Steel, Metal Ores, Non-Metallic Minerals, Coffee, Inorganic Chemicals, Forest Products, Vegetable Fats and Oils, Natural Rubber, Fertilizers, Organic Chemicals **Export**: Cereal Grains, Soybeans, Petroleum, Animal Feeds, Organic Chemicals, Paper and Liner Board, Vegetable Fats and Oils, Iron, Steel, Metal Ores and Scraps, Inorganic Chemicals
Foreign Trade Zone:	#2
Port Services:	**Pilot Associations** - 3 Pilots Associations, Federal Coastal Pilot Group. **Customs House Brokers** - 38 Custom House Brokers **Freight Forwarders** - 77 Companies **Stevedores** - 15 Stevedoring Companies
Transportation:	**Airport** - Nearest general passenger or commercial service - New Orleans International Airport. **Railroads** - Southern Pacific, CSX, Kansas City Southern, Illinois Central, Norfolk Southern, Union Pacific, New Orleans Public Belt **Truck Lines** - 57 Common Carriers, 18 Container Haulers, 51 Drayage Companies, 22 Heavy Haulers, 10 Refrigerated Truck Lines **Steamship Lines and Agents** - 71 Steamship Lines **Tank Farm** - 6 Tank Storage Companies **Ship and Barge Repair** - 19 Companies **Barge Lines** - 14 Common Carriers, Various Special and Exempt Carriers **Barge Fleeting Operation** - 15 Barge Fleeting Areas **Shipping Lines** - None **Towing and Tug Services** - offered by 12 companies
Oil and Gas Services:	None listed.

Source: Louisiana Department of Transportation and Development 1994

Table 22. Port of Morgan City.

Location:	Encompasses the major part of east St. Mary Parish.
Port Type:	Shallow draft 20 feet in main channel, 20 feet along side.
Major Commodities:	**Import**: Steel, Fuel, Limestone **Export**: Oilfield Machinery, Grain
Foreign Trade Zone:	None
Port Services:	**Pilot Associations** - Berwick-Morgan City Pilot Association. **Customs House Brokers** - N/A **Freight Forwarders** - N/A **Stevedores** - Berry Bros., Diamond Services, Sprit Enterprise.; Danos & Curole
Transportation:	**Airport** - Nearest general passenger or commercial service - Baton Rouge Regional Airport **Railroads** - Southern Pacific **Truck Lines** - Ace, Venture, Patterson, Western American **Steamship Lines and Agents** - N/A **Tank Farm** - None **Ship and Barge Repair** - McDermott, Conrad Industries, Hudson Drydocks **Barge Lines** - Canal Barge Company, Tidewater Marine, Thomas Barge Lines **Barge Fleeting Operation** - Basin Marine **Shipping Lines** - None **Towing and Tug Services** - Tidewater Marine, Garber Bros., Hornbeck Offshore, Northbank Towing
Oil and Gas Services:	None listed.

Source: Louisiana Department of Transportation and Development 1994

4.5. FARMLAND AND AGRICULTURAL RESOURCES.

The inventory of farmland and agricultural resources was prepared with data from the U. S. Department of Commerce, 1992 Census of Agriculture. The data presented are by parish and include: the total number of farms; land in farms; average size of farm in acres; total cropland - farms and acres; harvested cropland - farms and acres; irrigated land - farms and acres; cattle and calves inventory; beef cows inventory; milk cows inventory; cattle and calves sold; hogs and pigs inventory; hogs and pigs sold; sheep and lambs inventory; chickens inventory; broilers sold; and, selected crops harvested (Table 23).

The definitions of the elements presented are:

1. *Acres and quantity harvested* - Crops were reported in whole acres. If two or more crops were harvested from the same land during the year, the acres were counted for each crop. Therefore, the total acres of all crops harvested generally exceeds the total acres of cropland harvested. An exception to this procedure was hay crops. When more than one cutting of hay was taken from the same acres, the acres were counted only once but the quantity harvested included all cuttings. However, hay cut for both dry hay and green chop or silage were reported for each applicable crop. For interplanted crops or "skip-row" crops, acres were reported according to the portion of the field occupied by each crop. If a crop was planted but not harvested, the acres were not included as harvested. Corn and sorghum, hogged or grazed, were reported as cropland harvested. Quantity harvested was not obtained for crops such as vegetables; nursery and greenhouse crops; corn cut for dry fodder, hogged or grazed; and sorghum, hogged or grazed. Acres of land

in bearing and non-bearing fruit orchards, citrus or other groves, vineyards, and nut trees were reported as harvested cropland regardless of whether the crop was harvested or failed (U.S. Department of Commerce 1994).

2. *Crop year or season covered* - Acres and quantity harvested are for calendar year 1992 (U.S. Department of Commerce 1994).

3. *Cropland harvested* - This category includes land from which crops were harvested or hay was cut, and land in orchards, citrus groves, vineyards, nurseries, and greenhouses. Land from which two or more crops were harvested was counted only once (U.S. Department of Commerce 1994).

4. *Cropland total* - This category includes land from which crops were harvested or hay was cut; land in orchards, citrus groves, vineyards, nurseries, and greenhouses; cropland used only for pasture or grazing, land in cover crops, legumes, and soil-improvement grasses; land on which all crops failed; land in cultivated summer fallow; and idle cropland (U.S. Department of Commerce 1994).

5. *Irrigated land* - This category includes all land watered by any artificial or controlled means, such as sprinklers, furrows or ditches, and spreader dikes. Included are supplemental, partial, and preplant irrigation. Each acre is counted only once regardless of the number of times it was irrigated or harvested (U.S. Department of Commerce 1994).

6. *Land in farms* - This consists primarily of agricultural land used for crops, pasture, or grazing. It also includes woodland and wasteland not actually under cultivation or used for pasture or grazing, provided it was part of the farm operator's total operation. Large acreages of woodland or wasteland held for non-agricultural purposes were deleted from individual reports during processing operations. Land in farms includes acres set aside under annual commodity acreage programs as well as acres in the Conservation Reserve and Wetlands Reserve Programs for places meeting the farm definition. Land in farms is an operating unit concept and includes land owned and operated as well as land rented from others (U.S. Department of Commerce 1994).

7. *Crop units of measure* - Farm operators reported the quantity of field crops harvested in a unit of measure commonly used in the region. These include acres, bushels, bales, tons, and cwt. (hundredweight). The metric conversion for these is: 1 acre = 0.4047 hectare; 1 cwt. (hundredweight) = 100 pounds = 45.359 kilograms; and 1 ton = 2000 pounds = 0.907 metric ton. There are some variations among commodities in weight per unit of volume resulting from differences in size or variety of commodity. A bale of cotton = 217.724 metric kilograms; sorghum for grain reported in bushels = 25.401 metric kilograms; soybeans for beans reported in bushels = 27.216 metric kilograms; and wheat, all types reported in bushels = 27.216 metric kilograms (U.S. Department of Commerce 1994).

Table 23. Farms - Acreage, Crop Types/Production.

Item	Description	Louisiana	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines
Farms		25,652	325	100	58	412	17	128
Land in farms	acres	7,837,545	63,446	67,928	4,127	132,678	100	46,110
Avg. size	acres	306	195	679	71	322	6	360
Total cropland	farms	21,777	246	85	36	345	7	110
	acres	5,552,733	41,218	51,487	2,281	80,627	7	6,895
Harvested cropland	farms	17,171	152	75	20	275	7	92
	acres	3,810,690	23,749	34,991	313	50,761	7	3,923
Irrigated Land	farms	4,064	13	3	9	20	6	38
	acres	897,641	52	(D)	53	1,954	6	181
Livestock & poultry								
Cattle & Calves Inventory	farms	15,036	239	19	28	277	2	35
	number	844,260	10,891	671	819	19,792	(D)	5,685
Beef cows	farms	13,112	213	17	28	259	1	34
	number	441,725	6,346	378	478	12,824	(D)	3,555
Milk cows	farms	1,279	12	2	0	15	0	0
	number	78,976	26	(D)	0	26	0	0
Cattle & Calves Sold	farms	14,131	214	18	25	266	4	37
	number	375,903	4,268	398	320	9,035	(D)	2,911
Hogs and Pigs Inventory	farms	844	13	0	1	7	0	1
	number	37,519	70	0	(D)	79	0	(D)
Hogs & Pigs Sold	farms	534	9	0	0	4	0	1
	number	57,244	139	0	0	74	0	(D)
Sheep and Lambs Inventory	farms	468	6	0	3	9	0	0
	number	9,244	16	0	8	154	0	0
Chickens(3 month old +) Inventory	farms	1,344	15	0	4	14	0	3
	number	2,111,789	(D)	0	80	285	0	135
Broilers (& other meat types) sold	farms	313	0	0	0	0	0	0
	number	115,258,369	0	0	0	0	0	0

Table 23. Farms - Acreage, Crop Types/Production. (*continued*)

Item	Description	Louisiana	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines
Selected crops harvested:								
Sorghum for grain or seed	farms	875	0	0	0	0	0	0
	acres	179,376	0	0	0	0	0	0
	bushels	11,723,104	0	0	0	0	0	0
	acres	119,304	(D)	(D)	0	0	0	0
	bushels	4,432,764	16,360	(D)	0	0	0	0
Rice	farms	2,197	0	0	0	0	0	0
	acres	589,752	0	0	0	0	0	0
	cwt.	26,906,404	0	0	0	0	0	0
Cotton	farms	2,599	0	0	0	0	0	0
	acres	827,792	0	0	0	0	0	0
	bales	1,219,599	0	0	0	0	0	0
Soybeans	farms	3,903	4	4	0	2	0	0
	acres	1,112,815	1,380	514	0	(D)	0	0
	bushels	33,360,521	26,000	13,840	0	(D)	0	0
Sugarcane for sugar	farms	755	24	68	0	81	0	0
	acres	356,349	17,554	31,971	0	35,618	0	0
	tons	9,131,174	418,803	786,307	0	891,084	0	0
Hay, alfalfa, other grain	farms	8,956	110	3	8	168	0	5
	acres	383,292	3,509	(D)	224	11,399	0	(D)
	tons, dry	851,288	8,321	(D)	652	25,134	0	(D)

Source: U. S. Department of Commerce 1994.
Note: (D) - withheld to avoid disclosing data for individual farms.

Table 23. Farms - Acreage, Crop Types/Production. (*continued*)

Item	Description	St. James	St. John	St. Mary	Terrebonne	Total Study Area
Farms		63	26	101	139	1,436
Land in farms	acres	42,922	17,347	81,747	44,146	523,736
Avg. size	acres	681	667	809	318	
Total cropland	farms	60	24	90	114	1,177
	acres	40,575	11,183	71,074	27,581	343,482
Harvested cropland	farms	52	19	86	98	925
	acres	30,577	8,218	51,634	14,502	222,693
Irrigated Land	farms	4	2	2	6	105
	acres	(D)	(D)	(D)	33	2,279
Livestock & poultry						
Cattle & Calves Inventory	farms	8	14	21	71	768
	number	355	978	1,204	6,148	50,873
Beef cows	farms	8	14	19	69	715
	number	223	(D)	797	3,950	31,549
Milk cows	farms	0	1	0	3	36
	number	0	(D)	0	11	68
Cattle & Calves Sold	farms	6	14	19	66	723
	number	126	500	607	3,096	23,199
Hogs and Pigs Inventory	farms	0	0	2	4	31
	number	0	0	(D)	30	223
Hogs & Pigs Sold	farms	0	0	1	3	21
	number	0	0	(D)	26	291
Sheep and Lambs Inventory	farms	2	0	0	2	23
	number	(D)	0	0	(D)	178
Chickens(3 month old +) Inventory	farms	3	0	3	5	49
	number	42	0	47	(D)	589
Broilers (& other meat types) sold	farms	0	0	0	0	1
	number	0	0	0	0	0

Table 23. Farms - Acreage, Crop Types/Production. (*continued*)

Item	Description	St. James	St. John	St. Mary	Terrebonne	Total Study Area
Selected crops harvested:						
Sorghum for grain or seed	farms	0	0	0	0	0
	acres	0	0	0	0	0
	bushels	0	0	0	0	0
Wheat for grain	farms	4	0	0	0	8
	acres	656	0	0	0	656
	bushels	(D)	0	0	0	16,360
Rice	farms	0	0	0	0	0
	acres	0	0	0	0	0
	cwt.	0	0	0	0	0
Cotton	farms	0	0	1	0	1
	acres	0	0	(D)	0	0
	bales	0	0	(D)	0	0
Soybeans	farms	5	1	1	2	19
	acres	1,519	(D)	(D)	(D)	3,413
	bushels	54,583	(D)	(D)	(D)	94,423
Sugarcane for sugar	farms	42	8	71	26	322
	acres	26,842	6,677	47,836	10,759	177,257
	tons	771,232	179,356	1,065,036	286,683	4,398,501
Hay, alfalfa, other grain	farms	2	8	9	51	405
	acres	(D)	338	397	2,439	19,774
	tons, dry	(D)	1,195	1,002	4,723	43,830

Source: U. S. Department of Commerce 1994.
Note: (D) - withheld to avoid disclosing data for individual farms.

4.6. PUBLIC RESOURCES.

The inventory of public resources includes schools, highways, roads, bridges, railroads, the Strategic Petroleum Reserve, airports, navigation channels and structures, and publicly sponsored water resource projects such as completed wetlands conservation projects, hurricane protection projects, coastal restoration projects, municipal water supply and waste water treatment facilities. Commercial fisheries are documented in the Step E Report - Inventory and Assessment of Existing Environmental Resources (Sect. 3.3.3).

4.6.1. Schools

The school data in Table 24 was extracted from the Louisiana School Directory, published by the Louisiana Department of Education in 1991. Included in this information are the number of schools, parish location, total pupils per parish, and total faculty per parish. A complete listing of schools is provided in Appendix G.

Table 24. Public Resources - Schools.

Parish	No. of Schools	Total Pupils	Total Faculty
Ascension	4	2,434	205
Assumption	11	4,806	339
Jefferson	53	36,817	2,232
Lafourche	33	16,031	1,115
Orleans	9	6,185	430
Plaquemines	6	4,718	321
St. Charles	16	8,770	668
St. James	7	2,306	183
St. John	2	811	58
St. Mary	8	3,958	272
Terrebonne	43	21,050	1,422
Totals	192	107,886	7,245

Source: Louisiana Department of Education 1991.

4.6.2. Highways, Roads, and Bridges

Highways, roads and bridges are combined in one report, Table 25, as miles by parish. This information was provided by the Louisiana Department of Transportation and Development, Planning Division for 1994. This data is enumerated by local roads, city streets, interstate, other state maintained and total miles.

Table 25. Public Resources - Highways, Roads, and Bridges in Miles.

Parish	Local Roads	City Streets	Interstate	Other State Maintained	Total
Ascension	214.1	83.36	21.84	236.81	556.11
Assumption	147.63	4.65	0	182.75	335.03
Jefferson	1075.51	355.59	9.49	162.01	1602.6
Lafourche	389.92	89.95	0	296.65	776.52
Orleans	0	1394.92	34.92	62.15	1491.99
Plaquemines	147.34	0.52	0	116.14	264
St. Charles	148.53	0	20.72	114.23	283.48
St. James	80.88	27.23	6.84	122.36	237.31
St. John	162.2	0	29.22	76.29	267.71
St. Mary	193.92	156.77	0	174.85	525.54
Terrebonne	358.37	130.25	0	216.51	705.13
Total Study Area	2918.4	2243.24	123.03	1760.75	7045.42

Source: Louisiana Department of Transportation and Development 1995.

4.6.3. Railroads

The railroad information contained in Table 26 was obtained from the Railroad Safety Information System (RSIS) Line Segment Maps, authored by Applied Technology Research Corporation in 1993, under a contract with the Louisiana Department of Transportation and Development. This information includes railroad name, abbreviation, division name, location by parish, beginning milepost, ending milepost and total track miles.

Table 26. Public Resources - Railroads.

Railroad Name	Abbr.	Division Name	Location/ Parish	Beginning Milepost	Ending Milepost	Total Track Miles
Union Pacific	UP	NOLC1	Jefferson	1.5	10.2	8.7
Union Pacific	UP	Alexandria4	Ascension/St. James/St. Charles	10.2	65.1	54.9
Union Pacific	UP	Alexandria5	Assumption/Ascension	0	8.9	8.9
Southern Pacific	SP	Lafayette/Avondale2	Lafourche/St. Charles/Jefferson	10.5	41.2	30.7
Southern Pacific	SP	Lafayette/Avondale3	Terrebonne/Lafourche	41.2	55	13.8
Southern Pacific	SP	Lafayette/Avondale4	St. Mary/Terrebonne	55	106.5	51.5
New Orleans Public Belt	NOPB	System2	Jefferson	0	8.2	8.2
New Orleans Lower Coast Railroad	NOLR	NOLC	Jefferson/Plaquemines	0	38.14	38.14
Louisiana & Delta	LDRR	Lafayette/Avondale NAPO	Assumption/Lafourche	0	15.2	15.2
Louisiana & Delta	LDRR	Lafayette/AvondaleH1	Lafourche/Terrebonne	0	2.1	2.1
Total Track in Study Area						232.14

Source: Applied Technology Research Corporation 1993.

4.6.4. Strategic Petroleum Reserve

The Strategic Petroleum Reserve (SPR) information was provided by the U.S. Department of Energy, Strategic Petroleum Reserve Project Management Office. The creation of the Strategic Petroleum Reserve was mandated by Congress in Title I, Part B of the Energy Policy and Conservation Act (P. L. 94-163), December 22, 1975. The SPR provides the United States with sufficient petroleum reserves to mitigate the effects of an oil supply interruption. Currently the SPR consists of five active Gulf Coast underground salt dome oil storage facilities (three in Louisiana and two in Texas), a marine terminal facility (in Louisiana), and an administrative facility (in Louisiana). The pipeline terminals currently used by the SPR are the ARCO Terminal (Texas City, Texas), the Phillips Docks and Jones Creek Tank Farm (Freeport, Texas), the Sunoco Pipeline Terminal (Nederland, Texas), the Capline and LOCAP Pipeline Terminal from the Louisiana Offshore Oil Port (LOOP) (St. James, Louisiana), the Texas 22 to Lake Charles refineries and the SPR St. James Terminal. The sites are also capable of distributing crude oil via tank ships (U.S. Department of Energy 1988). This inventory presents only the St. James Terminal which alone is located within the study area.

Within the study area there is only one Strategic Petroleum Reserve Terminal - the St. James Terminal. It is situated on the west bank of the Mississippi River, 30 miles southeast of Baton Rouge in St. James Parish. It is the only terminal owned by the Department of Energy's Strategic Petroleum Reserve (U.S. Department of Energy 1988).

The terminal is located on 70 ha (173 acres) and contains two river docks, six storage tanks (two - million barrel total capacity), pumping and metering stations, and a control complex. Each dock can unload 40,000 barrels per hour from tankers - or load them at the same rate (U.S. Department of Energy 1988).

St. James terminal supplies the SPR Bayou Choctaw and Weeks Island storage sites. Oil is delivered to the terminal mainly by tankers using the Mississippi River. Oil can also be received from a pipeline connected to the Louisiana Offshore Oil Port (LOOP). The commercially owned Capline pipeline connects St. James with oil terminals in Patoka, Illinois, in the Midwestern refinery area (U.S. Department of Energy 1988).

St. James was designed for maximum flexibility, and its oil is pumped in a variety of ways, depending on its intended use. For temporary storage, oil is pumped between docked ships and aboveground storage tanks. For long-term storage, oil is pumped to Bayou Choctaw or Weeks Island. Oil can also be received from these storage sites for distribution by tankers if drawdown of the SPR reserves becomes necessary (U.S. Department of Energy 1988).

To speed the processing of crude oil for commercial use, the oil travels to refineries via existing pipelines (U.S. Department of Energy 1988).

Table 27. Public Resources - Strategic Petroleum Reserve.

ST. JAMES TERMINAL FACTS:	
No. of docks	2 (1 berth each dock)
Storage tanks	6
Tank shell capacity	2 million barrels
Tanker unloading	40,000 barrels/hour/dock
Terminal distribution	
Ships to dome storage	350,000 barrels/day
Dome storage to ships	350,000 barrels/day
Dome storage to distribution pipelines	720,000 barrels/day
Tanker size (each dock)	123,000 tons maximum loaded displacement
Terminal area	125 acres (42.5 ha)
Dock area	48 acres (19.4 ha)

Source: U.S. Department of Energy 1988.

4.6.5. Airports

Appendix H is an inventory of airports in the study area compiled from the Louisiana State Airport System Plan. Although somewhat dated (1974), this inventory is still useable and the airport listed, due to the magnitude of these resources, are still in operation. The inventory, however, should be considered a conservative estimate of the facilities located in the study area. It is further suggested that due to the significant oil and gas industry in the study area, heliports are significantly underreported.

4.6.6. Completed Wetlands Conservation Projects

The Completed Wetlands Conservation Projects in Table 28 were taken from the 1995 Summary of Completed State Funded Coastal Wetlands Conservation and Restoration Projects, provided by the Coastal Restoration Division of the Louisiana Department of

Natural Resources. These projects were completed during the period between 1986 through the spring of 1995. The projects (except the Terrebonne Isle Dernieres project) were funded totally with monies from the State of Louisiana without federal matching funds. This list excludes any projects completed with any federal funds. Projects with federal funding are included in Table 31. Public Resources - Water Resource Projects - Coastal Restoration Projects. Projects are listed according to project name, year completed, location by parish, and construction cost.

Table 28. Public Resources - Water Resource Projects- Completed Wetlands Conservation Projects.

Project Name	Year Completed	Parish	Cost ($)
Queen Bess Island	Nov-92	Jefferson	737,500
Grand Isle Bay Side Breakwaters	Aug-94	Jefferson	499,966
Subtotal Jefferson Parish			1,237,466
Pass Fourchon Closure and Beach Protection	1986	Lafourche	2,000,000
Kings Ridge Canal	Jul-89	Lafourche	15,000
Subtotal Lafourche Parish			15,000
Naomi (La Reussite) Diversion	Nov-92	Plaquemines	4,988,745
West Point A La Hache Diversion Siphon	Nov-92	Plaquemines	6,283,204
Subtotal Plaquemines Parish			11,271,949
Baie de Chactas	Apr-91	St. Charles	175,000
Subtotal St. Charles Parish			175,000
Atchafalaya Delta	Jun-92	St. Mary	7,500
Subtotal St. Mary Parish			7,500
Montegut Wetland	1989	Terrebonne	1,000,000
Bayou La Cache Wetland	Feb-91	Terrebonne	355,573
Wine Island Restoration	Sep-92	Terrebonne	554,564
Falgout Canal Wetland	Jul-93	Terrebonne	1,169,641
Montegut Wetland Levee Repair and Wetland Protection	Nov-93	Terrebonne	959,930
**Terrebonne Parish Project for E. Isle Dernieres	Mar-85	Terrebonne	900,000
Subtotal Terrebonne Parish			4,939,708
Totals			16,746,623

Source: Louisiana Department of Natural Resources, Coastal Restoration Division 1995b.
Source: T. Baker Smith 1996b.
** Funded by Terrebonne Parish.

4.6.7. Flood Control, Navigation and Hurricane Protection Projects

The Flood Control, Navigation, and Hurricane Protection Projects that follow are provided in a descriptive format, with historical background on the construction of these projects, changes in project design, purpose of project, areas protected or impacted, and some indication of costs at the time of construction. This information was assembled from a 1993 report published by the U. S. Army Corps of Engineers entitled *Water Resources Development in Louisiana.*

4.6.7.a. Flood Control Projects

1. *Harvey Canal-Bayou Barataria Levee* - This project consists of the construction of a levee along the Gulf Intracoastal Waterway in Jefferson Parish, between Roussel Pumping Station and Cousins Canal; enlargement of the existing levee from Cousins Canal to mile 6; and a new levee from mile 6 to LA State Highway 45 near Crown Point (U.S. Army Corps of Engineers 1993).

   Construction of the first lift of the left embankment was initiated in 1971 and completed in 1974. The project cost was $1 million (U.S. Army Corps of Engineers 1993).

4.6.7.b. Navigation Channels

1. *Barataria Bay Waterway* - The Rivers and Harbors Act of March 1919, authorized a dredged channel, 5 feet deep by 50 feet wide, from Bayou Villars to Grand Isle, a distance of 37 miles. The project was completed in 1925. A modification was authorized in 1958 to provide for a channel with a 12 foot depth and 125 foot wide at mean low Gulf level from the Intracoastal Waterway to Grand Isle. The channel follows the route of the original channel to mile 15.5, in

Bayou St. Denis, then by a relocated channel along the western shore of Barataria Bay and through Barataria Pass to the twelve foot contour in the Gulf of Mexico, with a 4.3-mile extension of the project to include the westerly 4.3 miles of Bayou Rigaud. The project modification was completed in 1963 (U.S. Army Corps of Engineers 1993).

In October 1967, authority was granted to enlarge the bar channel from 125 to 250 feet wide between mile 1.26 and the twelve foot contour. The enlargement was completed in 1967 at a cost of $204,400. In 1978, the project dimensions were increased again in the bar entrance channel to a depth of 15 feet mean low Gulf level by 250 feet wide, from mile 0 to the 15 foot contour of the Gulf of Mexico (U.S. Army Corps of Engineers 1993).

2. *Bayou Dupre* - This project includes a six-foot-deep channel from the highway bridge at Violet to deep water in Lake Borgne, with widths of 80 feet in the canal and bayou and 100 feet in the lake. In addition to the 7.3 mile channel, the project includes a turning basin 100 feet wide and 200 feet long at Violet. The Violet Lock, a privately owned connection with the Mississippi River, was permanently closed in 1950. This project was completed in 1939 (U.S. Army Corps of Engineers 1993).

3. *Gulf Intracoastal Waterway* - In Louisiana, the Gulf Intracoastal Waterway extends along the Gulf Coast from Lake Borgne Light 29 on the east, to the

Sabine River on the west, a distance of 302 miles; from Port Allen to Morgan City - 64 miles; from Plaquemine to Indian Village - 7.4 miles; and, to the town of Franklin via the Franklin Canal - 5.15 miles (U.S. Army Corps of Engineers 1993).

The project was authorized by the Rivers and Harbors Act of March 1925 and modified subsequently through the Rivers and Harbors Act of July 1946. These acts provide for the following dimensions in Louisiana (U.S. Army Corps of Engineers 1993):

- Main routes: 12 feet deep by 150 feet wide from Lake Borgne Light No. 29 to the Inner Harbor Navigation Canal, and 12 feet deep by 125 feet wide from the Mississippi River to the Sabine River (U.S. Army Corps of Engineers 1993).
- Alternate routes: 12 feet deep by 125 feet wide from Morgan City to the Mississippi River at Port Allen, and 9 feet deep by 100 feet wide from Plaquemine to Indian Village (U.S. Army Corps of Engineers 1993).
- The Franklin Canal is 8 feet deep by 60 feet wide from the Gulf Intracoastal Waterway to Franklin (U.S. Army Corps of Engineers 1993).

In addition to the navigational channels, locks were constructed as part of the Gulf Intracoastal Waterway. Table 29 contains a list of these locks and the associated costs, specifications and completion dates.

Table 29. Gulf Intracoastal Waterway: Locks.

Locks	Width in Feet	Length in Feet	Cost in Millions $	Date Completed
Inner Harbor Navigation Canal	74	640	8.648	1923
Harvey	75	415	1.775	1934
Leland Bowman	110	1,200	32.200	1985
Calcasieu	75	1,194	2.133	1950
Algiers	75	760	5.216	1956
Bayou Sorrel	56	790	4.701	1951
Bayou Boeuf	75	1,148	2.754	1954
Port Allen	84	1,188	13.902	1961

Source: U.S. Army Corps of Engineers 1993.

The Algiers Lock and Canal begin 6 miles west of the Harvey Lock and extend to the Mississippi River below Algiers. Federal cost of the project was $15.9 million with a non-federal share of $2.2 million (U.S. Army Corps of Engineers 1993).

The alternate route, which includes the Intracoastal Waterway from Morgan City to the Mississippi River, the lock at Port Allen, and the channel in Bayou Plaquemine from Indian Village to the lock at Plaquemine, was completed in 1962 at a federal coat of $26.87 million and non-federal cost of $2.25 million. In 1961, the Plaquemine Lock on the channel from Indian Village to the Mississippi River was permanently closed (U.S. Army Corps of Engineers 1993).

The total cost of work in Louisiana for the existing projects is $62.4 million, including $14.8 million non-federal share, and $72,000 for navigation aids (U.S. Army Corps of Engineers 1993).

4. *Bayou Lafourche and Lafourche-Jump Waterway* - This project was authorized in 1935. Features of the project included permanent closure of the head of Bayou Lafourche without a lock, a channel 6 feet deep by 60 feet wide from Napoleonville to Lockport, a channel of the same dimensions from the Gulf Intracoastal Waterway at Larose to the Gulf of Mexico with a jettied entrance at Belle Pass, and a closure of Pass Fourchon (U.S. Army Corps of Engineers 1993).

Construction of channel improvements below Larose were completed in 1941 at a cost of $524,024. The project between Thibodaux and the head of the bayou at Donaldsonville was deauthorized in 1967. The work between Thibodaux and Lockport is considered inactive because of lack of right-of-ways and dredged material disposal areas (U.S. Army Corps of Engineers 1993).

The project was modified in 1960 to provide for a channel 9 foot deep and 100 feet wide from Golden Meadow to Leeville to the Gulf, including modification and extension of the jetties to the twelve foot contour. Enlargement of Bayou Lafourche between Golden Meadow and the Gulf of Mexico has been completed (U.S. Army Corps of Engineers 1993).

5. *Bayou Segnette* - Improvements were made in this waterway in 1948. They consisted of re-establishing a usable navigation channel 6 feet deep and 40 feet

wide between Bayou Bardeaux and the westward end of the Westwego Canal, a distance of 6 miles (U.S. Army Corps of Engineers 1993).

Improvements made in 1951 consisted of channel enlargement to provide an 8 foot deep by 50 foot wide clear channel between mile 1.5 and mile 5.5 (U.S. Army Corps of Engineers 1993).

6. *Bayou Segnette Waterway* - Construction of a 9 foot deep channel over a 60 foot wide bottom width was authorized in 1954. An interim channel 8 feet deep over a bottom width of 80 feet, including overdepth, was completed in 1957 at a cost of $238,828. The estimated cost for the complete construction was $374,000 (in 1957) (U.S. Army Corps of Engineers 1993).

7. *Bayou Terrebonne* - This project was completed in 1916 at a cost of $120,089. The project provides for a six foot deep channel of suitable width from Bush Canal to the St. Louis Cypress Company Bridge at Houma, a distance of 24 miles. In 1959 and 1964, modifications were authorized for the abandonment of about one mile of the channel in Houma (U.S. Army Corps of Engineers 1993).

8. *Houma Navigation Canal* - The Houma Navigation Canal was originally built in 1962 by local interests (Terrebonne Port Commission 1985). The channel was built 15 feet deep by 150 foot bottom width and allows navigation from the Gulf Intracoastal Waterway near the western edge of Houma to the Gulf of Mexico. In

1973, authority was granted to increase the channel dimensions to 18 feet deep by 300 feet wide between mile 0 and the 18 foot contour in the Gulf of Mexico. Material dredged during channel maintenance was targeted to be used to restore wetlands and barrier islands (U.S. Army Corps of Engineers 1993). Material from the Houma Navigational channel was used to help maintain and restore Wine Island in 1994.

9. *Bayou Little Caillou* - Completed in 1929, this 20-mile channel is 5 foot deep and 40 foot wide from Robinson Canal to the head of Little Caillou Bayou. The cost of construction was $77,761 (U.S. Army Corps of Engineers 1993).

10. *Waterway from Empire to the Gulf of Mexico* - Authorized in 1946 and completed in 1950 at a cost of $1,068,142, this project consists of a 9 foot deep by 80 foot wide channel from Doullut Canal, near Empire, southward to the Gulf. Extension of the existing jetties from the six foot contour to the nine foot contour is authorized. The channel is ten miles long (U.S. Army Corps of Engineers 1993).

11. *Waterway from the Intracoastal Waterway to Bayou Dulac* - This waterway, 5 feet deep by 40 feet wide, extends from the Gulf Intracoastal Waterway at Houma, through bayous LeCarpe, Pelton, and Grand Caillou to Bayou Dulac, a distance of about 16.3 miles. The project was completed in 1938 (U.S. Army Corps of Engineers 1993).

Modification of the project was authorized in 1962 to provide a channel 10 feet deep and 45 feet wide in Bayou LeCarpe from the Gulf Intracoastal Waterway to the Houma Navigation Canal. This modification was completed in 1964 at a federal cost of $78,342 (U.S. Army Corps of Engineers 1993).

4.6.7.c. Hurricane Protection Projects

1. *Grand Isle Hurricane Protection and Beach Erosion* - This project, authorized in October 1976, provides for hurricane protection and prevention of beach erosion for the island. The plan for improvement provides for the construction of a sandfilled berm and a vegetated and sandfilled dune extending the length of Grand Isle's Gulf shore, and jetties to stabilize the ends of the island. The jetty on the western end of the island was constructed by the State of Louisiana. The vegetation and dune contracts were completed in the summer of 1985 (U.S. Army Corps of Engineers 1993).

In late 1985, the Grand Isle project was damaged by hurricanes Danny, Elena, and Juan. Approximately 6,000 feet of dune was completely lost, about 14,000 feet was partially lost, and the remaining 18,000 feet sustained no damage. It is estimated that the dune was instrumental in preventing an estimated $12 million in damages (U.S. Army Corps of Engineers 1993).

The project was restored in two phases. The first was completed in 1988 and provided for jetty extensions and sandbar removal. The second was completed in 1991 and provided for full restoration of the beach and dunes (U.S. Army Corps of Engineers 1993).

The project cost was \$33.1 million. As of October, 1992, the project was estimated to have prevented almost \$50 million in flood damages (U.S. Army Corps of Engineers 1993).

2. *Larose to Golden Meadow Hurricane Protection* - This project, authorized in 1965, protects highly developed residential and commercial areas along Bayou Lafourche between Golden Meadow and Larose from storm tides and hurricane floodwaters. The project includes enlargement of 3 miles of existing levees and construction of about 43 miles of new levees, 8 miles of low interior levees, two major floodgates in Bayou Lafourche, and several pump stations. The estimated federal cost (October 1992) is \$79.8 million and non-federal cost is \$34.2 million. The project is scheduled to be completed in the year 2002. As of 1992, it is estimated that this project has prevented \$14 million in flood damages (U.S. Army Corps of Engineers 1993).

3. *New Orleans to Venice Hurricane Protection* - This project was authorized in 1962. Features of the project include increasing the height and cross section of the existing back levees, constructing new back levees, modifying existing

drainage facilities, and raising the West Bank Mississippi River Levee from City Price to Fort Jackson to exclude tidal surges coming from the marshes to the east. Damages prevented under present conditions are estimated at $643.1 million (1989 price level) (U.S. Army Corps of Engineers 1993).

Total project costs are estimated to be $168 million - federal share, and $72 million non-federal. Location and estimated (October, 1992) total costs are shown in Table 30.

Table 30. Public Resources - Water Resource Projects- New Orleans to Venice Hurricane Protection.

Location	Estimated Cost ($)
Reach A, City Price to Empire	41,427,000
Reach B1, Empire to Fort Jackson	41,481,000
Reach B2, Fort Jackson to Venice	40,101,000
Reach C, Phoenix to Bohemia	25,347,000
West Bank Mississippi R. Levee - City Price to Venice	91,644,000
Total	240,000,000

Source: U.S. Army Corps of Engineers 1993.

The project completion date for all work is scheduled for the year 2013. As of September 1992 it is estimated that the project has prevented $47 million in damages (U.S. Army Corps of Engineers 1993).

4. *Westwego to Harvey Canal Hurricane Protection* - This project, authorized in 1986, will provide hurricane protection to the urban area west of the Harvey Canal

between Westwego and Harvey Canal. It will consist of about 22 miles of new and enlarged levees and floodwalls. Total value of all lands is $880 million and total of all improvements is $1.6 million. The project plan includes mitigation, which will be provided by the acquisition and management of 414 ha (1,024 acres) of wooded wetlands and construction of a timber pile breakwater to prevent erosion in the vicinity of the Salvador Wildlife Management Area. The estimated federal cost (October 1992) is $59.3 million and the non-Federal cost is $32 million. The project is scheduled for completion in the year 2002 (U.S. Army Corps of Engineers 1993).

4.6.8. Coastal Restoration Projects Proposed

The Coastal Restoration Projects in Table 31 were compiled from projects listed in the *Coastal Wetlands Planning, Protection, and Restoration Act - Summary of Priority Lists 1-4*, published by the Louisiana Department of Natural Resources in 1995. The information provided in these tables includes Project Name, Priority List, Project Type, Average Annual Habitat Units (AAHU), Average Annual Cost (AAC) per Average Annual Habitat Units, Created/Restored (C/R) Acres, Protected Acres, Total Created/Restored or Protected Acres, and Current ('93) Cost Estimated. The project types are: BI - Barrier Island, DM - Dredge Material, FD - Freshwater Diversion, HR - Hydrologic Restoration, MC - Marsh Creation, MM - Marsh Management, OM - Outfall Management, SD - Sediment Diversion, and SP - Shoreline Protection.

Table 31. Public Resources - Water Resource Projects- Coastal Restoration Projects.

Project Name	Priority List	Project Type	AAHU	AAC/ AAHU ($)	Created/ Restored (C/R) Acres	Protected (P) Acres	Total C/R & P Acres	Current ('93) Cost Est. ($)
Beneficial Use of Hopper Dredge Material (demo)	4	DM	N/A	N/A	N/A	N/A	N/A	300,000
GIWW to Clovelly Wetland	1	HR	9,510	68	0	6,144	6,144	8,174,525
West Point A La Hache Outfall Management	3	OM	429	140	104	983	1,087	894,137
Lake Salvador Shore Protection (demo)	3	SP	N/A	N/A	N/A	N/A	N/A	1,457,637
Barataria Bay Waterway Marsh Creation	1	DM	150	518	445	0	445	1,639,537
Jonathon Davis Wetland Protection	2	HR	485	657	0	510	510	3,418,802
Bayou Perot/ Bayou Rigolettes Marsh Restoration	3	MC	498	380	0	1,065	1,065	1,848,037
Bayou L'Ours Ridge Hydrologic Restoration	4	HR	615	394	0	737	737	2,418,676
Barataria Bay Waterway West Side Shoreline Protection	4	SP	213	2,310	56	176	232	2,192,418
Falgout Canal Plantings (demo)	1	VP	N/A	N/A	N/A	N/A	N/A	149,715
Timbalier Island Plantings (demo)	1	VP	N/A	N/A	N/A	N/A	N/A	416,365
Eastern Isle Dernieres (Phase O)	1	BI	45	13,949	9	0	9	6,350,163
Point au Fer	2	SP	158	696	0	375	375	1,091,724
West Belle Pass	2	DM	199	2,325	184	288	472	5,027,848
Isle Dernieres (Phase 1)	2	DM	120	6,195	49	60	109	6,917,897
East Timbalier Island Restoration (Phase 1)	3	BI	319	686	37	1,876	1,913	2,060,766
Lake Chapeau Marsh Creation & HR	3	HR	468	876	194	315	509	4,166,527
Whiskey Island Restoration	3	BI	549	921	447	792	1,239	4,857,766
Brady Canal Hydrologic Restoration	3	HR	337	337	0	297	297	4,731,929
East Timbalier Sediment Restoration (Phase 2)	4	DM	140	4,413	61	154	215	5,752,404
Flotant Marsh Fencing (demo)	4	SP	N/A	N/A	N/A	N/A	N/A	367,066

Source: Louisiana Department of Natural Resources. 1995a.

4.6.9. Public Water Supply

Public Water Supply - Table 32, Ground Water Usage - Table 33 and Surface Water Usage - Table 34 were taken from the 1995 report published by the U.S. Geological Survey entitled *Water Use in Louisiana, 1994*. This information is provided by Public Supplier name, location by parish, groundwater withdrawals in millions of gallons of water per day, and surface water usage in millions of gallons of water per day. The data is aggregated by public supply withdrawal, industrial withdrawal, power generation withdrawal, rural domestic withdrawal, livestock withdrawal, irrigation withdrawal, and aquaculture withdrawal.

1. *Public Supply* is defined as water withdrawn and delivered to a group of users by public and private water suppliers. This water is used for a variety of uses.

2. *Industrial withdrawal* refers to water withdrawn for industrial purposes such as process and production water, boiler feed, air conditioning, cooling, sanitation, washing and steam generation.

3. *Power generation withdrawal* refers to water withdrawn for thermoelectric power generation purposes.

4. *Rural domestic withdrawal* refers to water withdrawn by a person or family for personal home use.

5. *Livestock withdrawal* refers to water withdrawn for use in production of cattle, horses, sheep, swine, poultry, and other animals.

6. *Irrigation withdrawal* refers to any withdrawal of water for application to vegetation.

7. *Aquaculture withdrawal* refers to the withdrawal of water for fish, crawfish, or alligator farming (U.S. Department of the Interior 1995).

Table 32. Public Resources - Water Resource Projects- Public Water Supply.

Public Supplier	Parish	Ground Water Millions gal/day	Surface Water Millions gal/day
Capitol Utilities Corp.	Ascension	0.55	
Lambert's Water & Sewage	Ascension	0.28	
People's Water Service	Ascension		1.57
Assumption W. W. Dist. 1	Assumption		2.63
E. Jefferson W. W. Dist. 1	Jefferson		51.88
Gretna Water Works	Jefferson		3.91
W. Jefferson W. W. Dist. 2	Jefferson		24.92
Westwego Water System	Jefferson		1.90
Lafourche W. W. Dist. 1	Lafourche		7.94
Lockport Water System	Lafourche		0.20
Terrebonne W. W. Dist. 1	Lafourche		9.17
Thibodaux Water System	Lafourche		2.62
New Orleans Sewage & Water	Orleans		127.00
Plaquemines Parish W. W.	Plaquemines		5.74
St. Charles W. W. Dist. 1	St. Charles		3.35
St. Charles W. W. Dist. 2	St. Charles		3.81
Gramercy Water System	St. James		0.34
Lutcher Water System	St. James		0.46
St. James W. W. Dist. 1	St. James		0.74
St. James W. W. Dist. 2	St. James		0.91
St. John W. W. Dist. 3	St. John	2.34	2.46
Morgan City Water System	St. Mary		2.91
St. Mary Water Dist. 3	St. Mary		0.64
St. Mary Water Dist. 5	St. Mary		1.00
St. Mary Water Dist. 6	St. Mary		0.71
St. Mary W. W. Dist. 7	St. Mary	0.13	
Houma Water System	Terrebonne		7.33

Source: U.S. Department of the Interior 1995

Table 33. Public Resources - Water Resource Projects- Ground Water Usage.

Parish/ Source	Public Supply	Industrial	Power Generation	Rural Domestic	Livestock	Irrigation	Aquaculture
Ascension	1.82	11.67	0	2.24	0.05	0	0.12
Assumption	0	5.91	0	0.05	0	0	0
Jefferson	0	7.31	3.12	0.04	0	0.07	0
Lafourche	0	1.02	0	0.03	0.12	0	0.09
Orleans	0.8	1.94	19.06	0.17	0	0.02	0
Plaquemines	0	0	0	0.18	0	0	0
St. Charles	0	4.58	0	0.02	0.03	0	0
St. James	0	5.97	0	0.03	0	0	0
St. John the Baptist	2.34	6.77	0	0.04	0	0	0
St. Mary	0.15	2.26	0	0.16	0.01	0	2.97
Terrebonne	0	0.02	0	0.04	0	0	0.07

Source: U.S. Department of the Interior 1995.

Table 34. Public Resources - Water Resource Projects- Surface Water Usage.

Parish/Source	Public Supply	Industrial	Power Generation	Rural Domestic	Livestock	Irrigation	Aquaculture
Ascension	1.57	180.05	0	0	0.03	0	2.29
Assumption	2.63	4.62	0	0	0	0	4.91
Jefferson	82.62	7.19	959.49	0	0.02	0	0
Lafourche	19.94	8.17	0	0	0.03	0	35.94
Orleans	127	0	406.79	0	0	0	0
Plaquemines	5.74	105.44	0	0	0	0	2.42
St. Charles	7.16	377.13	2068.12	0	0.03	0	3.24
St. John the Baptist	2.46	91	0	0	0	0	0.6
St. Mary	8.17	45.14	162.27	0	0.01	0	11.89
Terrebonne	7.33	0	0	0	0.02	0	11.79

Source: U.S. Department of the Interior 1995.

Table 35. Water Resource Projects- Housing Units by Source of Water.

		Source of Water		
Parish	Total	Public System or Private Company	Individual Well	Some Other Source
Ascension	21,165	11,176	9,966	23
Assumption	8,644	8,506	93	45
Jefferson	185,072	184,802	54	216
Lafourche	31,332	31,224	3	105
Orleans	225,573	224,266	1,024	283
Plaquemines	9,432	9,213	37	182
St. Charles	16,016	15,931	33	52
St. James	6,934	6,880	30	24
St. John	14,255	13,924	241	90
St. Mary	21,884	21,127	524	233
Terrebonne	35,416	35,373	23	20
Total Study Area	575,723	562,422	12,028	1,273

Source: University of New Orleans 1993.

Table 36. Water Resource Projects- Housing Units by Sewage Disposal.

		Source of Disposal		
Parish	Total	Public Sewer	Septic Tank or Cesspool	Other Means
Ascension	21,165	8,654	11,930	581
Assumption	8,644	1,002	7,322	320
Jefferson	185,072	180,040	4,588	444
Lafourche	31,332	9,997	20,169	1,166
Orleans	225,573	221,846	1,814	1,913
Plaquemines	9,432	7,657	1,680	95
St. Charles	16,016	14,745	1,100	171
St. James	6,934	2,776	3,999	159
St. John	14,255	11,545	2,582	128
St. Mary	21,884	18,297	3,303	284
Terrebonne	35,416	21,409	13,155	852
Total Study Area	575,723	497,968	71,642	6,113

Source: University of New Orleans 1993.

An inventory of the existing freshwater treatment and distribution facilities is provided within the study area that includes the parishes of Terrebonne, Lafourche, Plaquemines, Jefferson, Assumption, St. James, St. John, St. Charles, and the City of Donaldsonville in Ascension Parish (T. Baker Smith & Son, Inc. 1996a, p. 53).

"The primary source of freshwater in Bayou Lafourche is through a pump station at Donaldsonville that diverts fresh water to Bayou Lafourche. The pump station has a maximum output of 340 ft^3/s (9.6 m^3/s) and usually operates at an average of ¾ of the maximum capacity. The total freshwater consumption along the bayou is approximately half of the average pumping capacity and serves approximately 250,000 people." (T. Baker Smith & Son, Inc. 1996a, p. 56).

Terrebonne Parish has three water treatment plants. "One plant uses Bayou Lafourche as a water source. It has a maximum output capacity of 16 million gallons/day [gpd] ($6x10^7$ liters/day [l/d]) and serves 75,000 people. The other two facilities are located in Houma where the Gulf Intracoastal Waterway (GIWW) is the water source. The plants can pump a maximum of 8 million and 4 million gpd ($3.0x10^7$ and $1.5x10^7$ l/d) respectively. These two facilities serve 40,000 people. The Bayou Lafourche facility is expected to expand to a 32 million gpd ($1.2x10^8$ l/d) capacity and phase out the two smaller Houma facilities." (T. Baker Smith & Son, Inc. 1996a, p. 57).

"Lafourche Parish has four freshwater distribution facilities which all use water from Bayou Lafourche. The two major facilities are located in Lockport and Thibodaux. The

Lockport and Thibodaux plants have maximum capacities of 8 million gpd ($3.0x10^7$ l/d) and 4 million gpd ($1.5x10^7$ l/d) respectively. (Personal communication with Eldon Breaux, 1995). A long-term plan for the Thibodaux facility includes adding a higher filtration system." (T. Baker Smith & Son, Inc. 1996a, p. 58). Lockport and Thibodaux each has a smaller municipal waterworks. "The Thibodaux municipal facility has a 3 million gpd ($1.1x10^7$ l/d) capacity (Personal communication with Jovan Marcke, 1995). This facility is currently being upgraded. The Lockport facility's maximum output capacity was unavailable, but the average water volume sold in 1992 was 235,000 gpd ($9x10^5$ l/d) (Personal communication with Joe Townsend, 1995)." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"Jefferson Parish has one water treatment plant on the East Bank and two on the West Bank of the Mississippi River. The East Bank facility has a maximum production capacity of 80 million gpd ($3.0x10^8$ l/d) (Personal communication with Blain Elstrott, 1995). This facility is projected to expand to a capacity of 100 million gpd ($3.8x10^8$ l/d). The West Bank waterworks can produce 34 million and 10 million gpd ($1.3x10^8$ and $3.8x10^7$ l/d) respectively (Personal communication with Dale Hymmel, 1995)." (T. Baker Smith & Son, Inc. 1996a, p. 58). "Two other smaller facilities exist within the Parish, but lie within the region covered by the larger water treatment plants and are significantly smaller in comparison." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"Assumption Parish has one treatment plant that serves 28,000 people. Its maximum production rate is 5 million gpd ($1.9x10^7$ l/d). The plant works on an average capacity of approximately ½ of the maximum production capacity." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"St. John the Baptist Parish has two waterworks plants and two Artesian wells that serve a total of 45,000 people. The wells combine to produce 5 million gpd. The water treatment plants can produce 0.7 million and 1.2 million gpd ($3x10^6$ and $5x10^6$ l/d) (Personal communication with Kent Hachet, 1995)." (T. Baker Smith & Son, Inc. 1996a, p. 58). "There are plans for future renovations to these water treatment plants (Per communication with Kent Hachet, 1995)." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"St. Charles Parish has two water treatment facilities. The East Bank facility has a maximum production rate of 7 million gpd ($2.6x10^7$ l/d). The West Bank facility has been recently upgraded to produce 9 million gpd ($3.4x10^7$ l/d). These facilities combine to serve 42,000 people." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"St. James Parish has two water distribution facilities serving 16,000 people. The East Bank plant has a maximum output capacity of 1.75 million gpd ($7x10^6$ l/d) with future plans of capacity expansion. The West Bank facility can produce 3 million gpd ($1.3x10^7$ l/d)." (T. Baker Smith & Son, Inc. 1996a, p. 58).

"Plaquemines Parish serves 24,000 people and has five water treatment plants on the Mississippi River." (T. Baker Smith & Son, Inc. 1996a, p. 58). The plants are: Belle Chase with an output capacity 5.0 million gpd; Port Sulphur with an output capacity of 3.0 million gpd; Boothville with an output capacity of 2.0 million gpd; Dalcour with an output capacity of 1.0 million gpd; and East Pointe a la Hache with an output capacity of 0.75 million gpd (1 gallon = 3.8 liters). "Recently, the Belle Chasse facility has received funding from the Corps of Engineers to increase the production capacity to 8 million gpd (3.0×10^7 l/d) (Personal communication with Charles Lambert, 1995)." (T. Baker Smith & Son, Inc. 1996a, p. 59).

4.7. PARKS AND RECREATIONAL FACILITIES.

The information presented for the parks and recreational facilities inventory (Appendix I) was obtained from the Louisiana Department of Culture, Recreation, and Tourism's Outdoor Recreation Facilities Inventory. The data is aggregated by parish, (within the study area); type - federal, state, parish, local government, commercial, and non-profit operated; name of facility; total acreage; outdoor game fields; swimming areas, including beaches or pools; picnic areas and tables; boat ramps and lanes; camping sites and acres; and hunting acres.

Based on this inventory, the study area has approximately 66,657 hectares (164,707 total acres) of recreational land, of which 65,419 hectares (161,647 acres) are designated for hunting.

4.8. ARCHEOLOGICAL SITES.

The Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Division of Archeology has on file 1486 reported archeology sites within the study area. A review of the site files indicates that 727 are south of the Gulf Intracoastal Waterway (Table 37). This represents nearly 50 percent of the sites. Of these, the greatest number are in Jefferson, Lafourche, Plaquemines, St. Mary and Terrebonne Parishes. The vast majority of these sites are Indian middens. They are not burial sites.

Table 37. Archeological Sites.

Parish	Number of Reported Archeological Sites	Sites South of GIWW
Ascension	56	0
Assumption	47	0
Jefferson	214	90
Lafourche	250	211
Orleans	139	0
Plaquemines	151	0
St. Charles	76	53
St. James	51	0
St. John the Baptist	59	0
St. Mary	158	101
Terrebonne	285	272
Totals	1486	727

Source: Louisiana Division of Archeology, February 1996.

The Division of Archeology categorizes each site by: landform, soil area, cultural features, cultural affiliation, site function, description of material, method of investigation, disturbance agent/present use, disturbance degree, and National Register status. Each site is identified by a code that allows it to be categorized (Table 38).

Table 38. Archeological Sites: Coding.

Landform:	Knoll, ridge, bench, pimple mound, salt dome, swamp, backswamp, marsh, beach, underwater, natural levee, cheniere, natural relic scar, batture, other.
Soil Area:	Coastal plain, coastal marsh, flatwoods, recent alluvium, coastal prairies, Mississippi terrace and loessial hills.
Cultural Feature:	Single, artifact, mound/earthwork, mounds/earthwork, historic earthwork, other earthwork, shipwrecks, prehistoric scatter, historic scatter, historic sheet midden, shell midden, earth midden, lithic scatter, burials, standing structure, dump, and historic ruins.

Table 38. Archeological Sites: Coding. *(continued)*

Cultural Affiliation:	Prehistoric (unknown), historic (unknown), prehistoric and historic (unknown), paleo-Indian, meso-Indian/archaic, neo-Indian (unknown), Poverty Point, Tchefuncte, Marksville, Issaquena, Baytown, Troyville, Coles Creek, Plaquemine, Mississippian, Caddo, historic Indian contact, historic exploration 1541-1803, antebellum 1803-1860, war and aftermath 1860-1890, industrial and modern 1890 to the present.
Site Function:	Prehistoric (unknown), historic (unknown), chipping station, camp, extraction locale, hamlet/village, ceremonial center, farmstead, watercraft, plantation, historic town/village, urban, cemetery, historic transportation, commercial/service center, institution (religious and education), governmental, industrial, dump, and military
Description of Material:	Ceramics (aboriginal), ceramics (historic), chipped stone, projectile points, ground stone, human bone, shell, glass, metal, worked bone, unmodified bone (fauna), flora wood, and construction material (brick, wattle and daub).
Method of Investigation at Site:	Grab surface collection, systematic collection, shovel testing, auger testing, test units, excavation, remote sensing, diver investigations, and other.
Disturbance Agent/Present Use:	Unknown, potted, none, agriculture (plowing), timber industry, natural, developed (urban), construction (water), construction (other), underwater, and other.
Disturbance Degree:	Unknown, none, minor impact, major impact, destroyed, and inundated.
National Register Status:	Unknown, not eligible, listed, declared eligible, potential significant, and National Landmark.

Source: Louisiana Division of Archeology 1996.

In addition, the state Division of Historic Preservation maintains records on structures within these parishes that are more than 50 years old. The files are not complete (Lafourche and Plaquemines have not been added to the record). Even though the surveys are incomplete, those that have been completed indicate that in the parishes covered by the survey there are 8,894 structures that are at least 50 years old (Table 39). New Orleans is categorized by Historic Districts and will not add significantly to this number since most of these structures are in the portion of the parish east of the Mississippi river.

Table 39. Historic Structures.

Parish	Number of Structures
Ascension	714
Assumption	1,859
Jefferson	289
Lafourche	n/d
Orleans	(Categorized by Historic Districts)
Plaquemines	n/d
St. Charles	405
St. James	1,790
St. John the Baptist	1,118
St. Mary	1,611
Terrebonne	1,111
Total Historic Structures	8,897

Source: Louisiana Division of Archeology 1996.

5.0 VALUATION OF ECONOMIC RESOURCES

The valuation of economic resources was computed using various methods, depending upon the data available. These methods are described for each of the economic resources including: residential structures; commercial property; oil and gas drilling rigs, pipelines, wells, and surface equipment; farm sales, property and crop values; schools; highways, roads and bridges; and track values. All other values are described as available within earlier sections of this report.

5.1. VALUE OF RESIDENTIAL STRUCTURES

The estimated value of occupied and vacant housing was calculated using the median (dollar) values of owner-occupied and vacant-for-sale housing units for each parish, multiplied by the occupied and vacant housing units per block group and total units in the parish. The median values used were prepared by the Census (1990) using self reported data for only "specified owner-occupied housing units" and "specified vacant-for-sale housing units". The median values for the "specified owner-occupied housing units" are calculated by block group. The median values for the "specified vacant-for-sale housing units" are by parish only. This excludes mobile homes, houses with a business or medical office, houses on 10 or more acres, and housing units in multi-unit buildings. (See Appendix J for a complete list of housing unit values.)

Table 40. Residential Structures: Value Summary.

Parish	Total HU	Occupied Housing	Est. Value Occupied ($)	Vacant Housing	Est. Value Vacant ($)
Ascension	21,165	19,337	1,143,337,600	1,828	71,292,000
Assumption	8,644	7,397	331,765,600	1,247	33,419,600
Jefferson	72,877	63,088	3,685,890,104	9,789	562,867,500
Lafourche	31,332	28,835	1,520,941,300	2,497	87,145,300
Orleans	23,444	19,582	1,328,581,000	3,862	221,678,800
Plaquemines	8,561	7,455	450,992,200	1,106	57,622,600
St. Charles	7,843	6,946	411,658,200	897	61,713,600
St. James	2,931	2,749	143,150,800	182	6,897,800
St. John	1,321	1,114	48,198,300	207	11,157,300
St. Mary	6,934	6,164	289,906,100	770	26,950,000
Terrebonne	35,416	31,837	1,674,319,079	3,579	149,602,200
Totals	220,468	194,504	11,028,740,283	25,964	1,290,346,700

Source: U.S. Department of Commerce 1992.

5.2. VALUE OF COMMERCIAL PROPERTY

The valuation of Commercial Property was acquired from the 1993 Biennial Report of the Louisiana Tax Commission. This is presented by parish and aggregated by Land: All Other; Improvements: All Others; Inventories; Machinery and Equipment; and Business Furniture and Fixtures. The values given are fair market values, defined as the price for property which would be agreed upon between a fully informed buyer and seller, under normal circumstances.

Table 41. Commercial Property: Fair Market Value or Use Value

Parish	Land: All Other	Improvements All Others	Inventories	Machinery & Equipment	Bus. Furn. & Fixtures	Parish Totals
Ascension	137,061,200	168,828,733	289,400,067	805,645,733	14,263,067	1,415,198,800
Assumption	48,039,400	34,576,467	59,975,333	50,115,200	5,045,533	197,751,933
Jefferson	2,428,934,640	1,910,300,473	781,074,607	521,147,080	203,530,427	5,844,987,227
Lafourche	161,271,900	96,083,667	67,677,333	65,258,933	16,008,800	406,300,633
Orleans	2,033,913,330	2,499,918,107	390,641,467	514,183,673	317,626,687	5,756,283,264
Plaquemines	277,160,300	122,324,533	223,002,233	340,579,600	6,585,933	969,652,599
St. Charles	232,528,730	158,762,407	267,229,653	1,359,857,713	30,041,040	2,048,419,543
St. James	54,316,000	24,841,547	175,947,667	468,526,567	3,393,000	727,024,781
St. John	78,765,940	82,723,793	169,678,467	407,468,400	8,148,747	746,785,347
St. Mary	174,827,320	133,374,460	106,038,947	77,322,453	24,709,040	516,272,220
Terrebonne	318,784,300	293,566,900	105,928,700	165,162,667	31,786,333	915,228,900
Totals	5,945,603,060	5,525,301,087	2,636,594,474	4,775,268,019	661,138,607	19,543,905,247

Source: Louisiana Tax Commission 1994.

5.3. VALUE OF INDUSTRIAL STRUCTURES AND FACILITIES - OIL AND GAS

The valuation of oil and gas - drilling rigs, pipelines, wells, and surface equipment was also acquired from the 1993 Biennial Report of the Louisiana Tax Commission. The assessment of these oil and gas properties was made in accordance with the Louisiana Constitution of 1974, Article VII, Section 18, and in accordance with guidelines adopted by the Tax Commission and applied uniformly throughout the state. The standard for valuation of these oil and gas properties is fair market value. Appropriate allowance is made by each tax assessor for depreciation and obsolescence, where necessary.

Table 42. Industrial: Oil and Gas Fair Market Values (Dollars).

Parish	Drilling Rigs Fair Market Value	Pipelines Fair Market Value	Number of Wells	Oil & Gas Wells Fair Market Value	Oil & Gas Surface Equipment Fair Market Value
Ascension	N/R	17,161,133	N/R	2,917,467	8,806,000
Assumption	658,467	26,977,467	124	13,035,600	4,539,667
Jefferson	211,367	9,388,347	N/R	43,384,527	24,934,227
Lafourche	1,806,933	66,084,533	2,169	140,820,067	27,296,067
Orleans	N/R	N/R	N/R	N/R	N/R
Plaquemines	3,545,733	20,361,533	5,083	243,254,533	187,296,600
St. Charles	94,500	34,777,667	514	26,826,580	36,587,667
St. James	5,400	13,030,400	66	4,214,000	18,868,933
St. John	N/R	6,639,187	34	1,661,413	1,435,353
St. Mary	2,099,107	30,790,767	1,764	133,597,093	50,657,787
Terrebonne	N/R	31,341,967	N/R	216,889,833	91,589,800
Totals	8,421,507	256,553,001	9,754	826,601,113	452,012,101

Source: Louisiana Tax Commission 1994.

5.4. VALUE OF PORT FACILITIES

The port facilities described within Section 4.4 of this report reflect a partnership between public infrastructure and private business facilities. These facilities provide valuable services to the oil and gas industry, as well as export and import opportunities for other businesses. The very nature of these partnerships does not lend itself to an accounting of value of the infrastructure located there. Although there is no estimated value for each port facility, the valuation of commercial and industrial structures as assessed by the Louisiana Tax Commission would include any private businesses tenants of each port.

5.5. VALUE OF AGRICULTURAL PROPERTY AND CROPS

The farm sales, property and crop values for the study area were compiled from data in the U.S. Department of Commerce, Census of Agriculture, 1992. *Total Sales* represents the gross market value of agricultural products sold before taxes and expenses, including livestock, poultry, and their products; and, crops, including nursery and greenhouse crops, and hay. This data is also aggregated by commodity group. Estimated market value of land and buildings is self-reported by farmers to the Census. This market value refers to the value the land and buildings would sell for under current market conditions. If the value of the land and buildings was not reported, it was estimated by the Census, using the average value of land and buildings from a similar farm in the same geographic area.

Table 43. Farms: Sales by Commodity Group.

Item	Louisiana	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines	St. Charles	St. James
Total Sales									
1992 - farms	25,652	325	100	58	412	17	128	67	63
1987 - farms	27,350	263	118	102	366	7	117	72	75
1992 - $1,000	1,607,511	15,049	20,395	1,419	27,078	437	2,506	4,054	19,525
1987 - $1,000	1,340,162	12,359	21,653	1,081	22,115	(D)	2,406	(D)	15,823
1992 - Avg. per farm $	62,666	46,305	203,952	24,458	65,723	25,721	19,575	60,502	309,922
1987 - Avg. per farm $	49,000	46,992	183,496	10,602	60,422	(D)	20,567	(D)	210,979
Sales by commodity group:									
Crops incl. nurs. & grhse crops									
1992 - farms	10,720	59	72	13	134	7	52	10	52
1987 - farms	11,718	63	87	19	120	6	47	13	60
1992 - $1,000	1,111,346	13,226	19,368	1,266	23,201	411	1,407	2,786	19,461
1987 - $1,000	929,858	10,908	21,501	671	19,638	272	644	(D)	15,446
Grains									
1992 - farms	5,441	6	5	1	4	0	0	0	8
1987 - farms	6,602	9	2	2	3	0	0	1	14
1992 - $1,000	454,443	202	(D)	(D)	(D)	0	0	0	424
1987 - $1,000	413,471	671	(D)	(D)	5	0	0	(D)	1,089
Corn for grain									
1992 - farms	1,190	0	0	1	2	0	0	0	1
1987 - farms	1,135	0	0	2	1	0	0	1	5
1992 - $1,000	69,867	0	0	(D)	(D)	0	0	0	(D)
1987 - $1,000	34,889	0	0	(D)	(D)	0	0	(D)	(D)
Wheat									
farms - 1992	677	3	1	0	0	0	0	0	4
farms - 1987	1,060	3	2	0	1	0	0	0	6
1992 - $1,000	14,710	(D)	(D)	0	0	0	0	0	(D)
1987 - $1,000	12,555	(D)	(D)	0	(D)	0	0	0	(D)

Table 43. Farms: Sales by Commodity Group. *(continued)*

Item		Louisiana	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines	St. Charles	St. James
Soybeans										
	1992- farms	3,889	4	4	0	2	0	0	0	5
	1987 - farms	4,988	7	0	0	1	0	0	0	10
	1992 - $1,000	173,475	145	75	0	(D)	0	0	0	324
	1987 - $1,000	206,419	(D)	0	0	(D)	0	0	0	951
Sorghum for grain										
	1992- farms	853	0	0	0	0	0	0	0	0
	1987 - farms	753	0	0	0	0	0	0	0	0
	1992 - $1,000	24,002	0	0	0	0	0	0	0	0
	1987 - $1,000	11,593	0	0	0	0	0	0	0	0
Barley										
	1992 - farms	0	0	0	0	0	0	0	0	0
	1987 - farms	0	0	0	0	0	0	0	0	0
	1992 - $1,000	0	0	0	0	0	0	0	0	0
	1987 - $1,000	0	0	0	0	0	0	0	0	0
Oats										
	1992 - farms	65	1	0	0	0	0	0	0	0
	1987 - farms	64	0	0	0	0	0	0	0	0
	1992 - $1,000	349	(D)	0	0	0	0	0	0	0
	1987 - $1,000	363	0	0	0	0	0	0	0	0
Other grains										
	1992 - farms	2,201	0	0	0	0	0	0	0	0
	1987 - farms	2,284	0	0	0	0	0	0	0	0
	1992 - $1,000	172,039	0	0	0	0	0	0	0	0
	1987 - $1,000	147,651	0	0	0	0	0	0	0	0

Table 43. Farms: Sales by Commodity Group. *(continued)*

Item	St. John	St. Mary	Terrebonne	Total Study Area
Total Sales				
1992 - farms	26	101	139	1,436
1987 - farms	39	88	145	1,392
1992 - $1,000	4,459	26,572	8,297	129,791
1987 - $1,000	4,910	24,415	4,978	109,740
1992 - Avg. per farm $	171,511	263,089	59,692	
1987 - Avg. per farm $	125,897	277,441	34,332	
Sales by commodity group:				
Crops incl. nurs. & grhse crops				
1992 - farms	14	77	54	544
1987 - farms	23	69	57	564
1992 - $1,000	4,265	26,364	6,670	118,425
1987 - $1,000	4,816	24,271	4,166	102,333
Grains				
1992 - farms	2	1	2	29
1987 - farms	3	1	7	42
1992 - $1,000	(D)	(D)	(D)	626
1987 - $1,000	159	(D)	121	2,045
Corn for grain				
1992 - farms	1	0	0	5
1987 - farms	2	1	0	12
1992 - $1,000	(D)	0	0	0
1987 - $1,000	(D)	(D)	0	0
Wheat				
farms - 1992	0	0	0	8
farms - 1987	0	1	3	16
1992 - $1,000	0	0	0	0
1987 - $1,000	0	(D)	(D)	0

Table 43. Farms: Sales by Commodity Group. *(continued)*

Item		St. John	St. Mary	Terrebonne	Total Study Area
Soybeans					
	1992- farms	1	1	2	19
	1987 - farms	2	0	4	24
	1992 - $1,000	(D)	(D)	(D)	544
	1987 - $1,000	(D)	0	99	1,050
Sorghum for grain					
	1992- farms	0	0	0	0
	1987 - farms	1	0	1	2
	1992 - $1,000	0	0	0	0
	1987 - $1,000	(D)	0	(D)	0
Barley					
	1992 - farms	0	0	0	0
	1987 - farms	0	0	0	0
	1992 - $1,000	0	0	0	0
	1987 - $1,000	0	0	0	0
Oats					
	1992 - farms	0	0	0	1
	1987 - farms	0	0	1	1
	1992 - $1,000	0	0	0	0
	1987 - $1,000	0	0	(D)	0
Other grains					
	1992 - farms	0	0	0	0
	1987 - farms	0	1	0	1
	1992 - $1,000	0	0	0	0
	1987 - $1,000	0	(D)	0	0

Source: U. S. Department of Commerce 1994

Table 44. Farms: Property and Crop Values.

Item	Louisiana	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines	St. Charles
Est. Market Value of Land & Buildings								
Avg. per farm ($)	291,332	431,414	654,300	123,202	372,132	180,471	500,597	395,885
Avg. per acre ($)	972	2,186	937	1,762	1,147	30,680	1,321	1,144
Est. Market Value of Mach. & Equip.								
Avg. per farm ($)	46,299	54,198	167,259	18,821	61,567	14,493	26,731	36,843
Mkt. value of ag. products sold ($1,000)	1,607,511	15,049	20,395	1,419	27,078	437	2,506	4,054
Avg. per farm ($)	62,666	46,305	203,952	24,458	65,723	25,721	19,575	60,502
Crops: incl. nurs. & grhse crops ($1,000)	1,111,346	13,226	19,368	1,266	23,201	411	1,407	2,786
Livestock, poultry & products ($1,000)	496,165	1,824	1,027	152	3,877	26	1,099	1,268
Total farm production expenses ($1,000)	1,309,012	13,003	15,441	994	22,152	355	2,253	3,007
Avg. per farm ($)	51,026	39,886	154,414	17,131	53,637	20,857	17,601	44,878
Net cash return from ag. sales per unit								
# of farms	25,654	326	100	58	413	17	128	67
$1000	268,077	2,623	5,063	397	5,480	83	300	1,047
Avg. per farm ($)	10,450	8,047	50,626	6,849	13,270	4,864	2,346	15,624

Table 44. Farms: Property and Crop Values. *(continued)*

Item	St. James	St. John	St. Mary	Terrebonne	Total Study Area
Est. Market Value of Land & Buildings					
Avg. per farm ($)	1,143,781	832,603	1,124,224	369,509	
Avg. per acre ($)	1,679	1,248	1,389	1,295	
Est. Market Value of Mach. & Equip.					
Avg. per farm ($)	200,047	148,968	204,537	69,818	
Mkt. value of ag. products sold ($1,000)	19,525	4,459	26,572	8,297	129,791
Avg. per farm ($)	309,922	171,511	263,089	59,692	
Crops: incl. nurs. & grhse crops ($1,000)	19,461	4,265	26,364	6,670	118,425
Livestock, poultry & products ($1,000)	64	194	208	1,627	11,366
Total farm production expenses ($1,000)	16,169	3,876	23,286	6,692	107,228
Avg. per farm ($)	256,648	149,060	230,552	48,145	
Net cash return from ag. sales per unit					
# of farms	63	26	101	139	1,438
$1000	3,356	584	3,286	1,782	24,001
Avg. per farm ($)	53,274	22,451	32,537	12,817	

Source: U. S. Department of Commerce 1994.

5.6. VALUE OF PUBLIC RESOURCES - SCHOOLS

There is no known single source for valuation of schools in the study area. In lieu of previous construction cost, a calculated value is provided. This value is based on a minimum of 35 square feet per pupil of classroom space (The Children First Act. No. 659. 1988) multiplied by a current construction cost of $80.00 per square foot, provided by Wayne Corne, AIA (Lafayette, LA). The values presented are a conservative estimate of replacement cost for classroom space only and do not include such space as parking, gymnasiums, cafeterias, etc.

Table 45. Schools: Estimated Construction Cost - Classroom Space Summary.

Parish	Total Pupils	Sq. Feet @ 35 sf./Pupil	Estimated Construction Cost @ $80/sf. ($)
Ascension	2,434	85,190	6,815,200
Assumption	4,806	168,210	13,456,800
Jefferson	36,817	1,288,595	103,087,600
Lafourche	16,031	561,085	44,886,800
Orleans	6,185	216,475	17,318,000
Plaquemines	4,718	165,130	13,210,400
St. Charles	8,770	306,950	24,556,000
St. James	2,306	80,710	6,456,800
St. John	811	28,385	2,270,800
St. Mary	3,958	138,530	11,082,400
Terrebonne	21,050	736,750	58,940,000
Totals	107,886	3,776,010	302,080,800

Source: Louisiana Department of Education 1991.
Source: Corne, Wayne, AIA 1996.
Source: Louisiana State Legislature. The Children First Act. No. 659. 1988.

5.7. VALUE OF PUBLIC RESOURCES - HIGHWAYS, ROADS AND BRIDGES

Highway, road and bridge values are cost estimates based on construction type and the estimated cost-per-mile provided by the Louisiana Department of Transportation and Development, Road Design Section. Costs-per-mile are based on current estimates of new construction. The values used include: Urban major widening $3.5 million per mile - City Streets in Jefferson and Orleans Parishes; urban interstate reconstruction $3.5 million per mile - interstate in Orleans and Jefferson Parishes; rural interstate reconstruction $1.5 million per mile - interstate in all other parishes; rural major widening $2.5 million per mile - city street in all other parishes; rural reconstruction $750,000 per mile - local roads and other state maintained roads.

Table 46. Highways/Roads/Bridges: Cost Estimates.

Type Construction	Estimated Cost Per Mile
Urban major widening (including 5 laning)	$3.5 million
Urban interstate widening (in median - no major interchange modifications)	$5.0 million
Urban major widening (new elevated)	$30 million
Urban interstate widening (with major interchange modifications)	$9.0 million
Urban interstate reconstruction	$3.5 million
Rural interstate reconstruction	$1.5 million
Interstate resurfacing (urban & rural)	$1.25 million
Rural major widening	$2.5 million
Rural asphalt overlay (2 lanes, resurfacing only)	$100,000
Rural asphalt overlay (2 lanes, base improvement)	$200,000
Rural reconstruction (2 lanes)	$750,000
Rural multi-lane reconstruction	$1.5 million
Reseal (2 lanes)	$40,000
Structures (Bridges)	$40 per square foot of deck for new $60 per square foot of added deck for widening
Isolated reconstruction	$250,000 per spot

Source: Louisiana Department of Transportation and Development 1996.

Table 47. Estimated Highway/Road/Bridge - Cost of Reconstruction.

Parish	Local Roads	Value $ Millions	City Streets	Value $ Millions	Interstate	Value $ Millions	Other State Maintained	Value $ Millions	Total Miles	Total Value $ Millions
Ascension	214.1	160.6	83.4	208.4	21.8	32.8	236.8	177.6	957.8	579.3
Assumption	147.6	110.7	4.7	11.6	0.0	0.0	182.8	137.1	457.4	259.4
Jefferson*	1,075.5	806.6	355.6	1,244.6	9.5	33.2	162.0	121.5	3,687.0	2,205.9
Lafourche	389.9	292.4	90.0	224.9	0.0	0.0	296.7	222.5	1,293.8	739.8
Orleans*	0.0	0.0	1,394.9	4,882.2	34.9	122.2	62.2	46.6	6,496.4	5,051.1
Plaquemines	147.3	110.5	0.5	1.3	0.0	0.0	116.1	87.1	375.8	198.9
St. Charles	148.5	111.4	0.0	0.0	20.7	31.1	114.2	85.7	426.0	228.2
St. James	80.9	60.7	27.2	68.1	6.8	10.3	122.4	91.8	376.3	230.8
St. John	162.2	121.7	0.0	0.0	29.2	43.8	76.3	57.2	433.2	222.7
St. Mary	193.9	145.4	156.8	391.9	0.0	0.0	174.9	131.1	1,062.9	668.5
Terrebonne	358.4	268.8	130.3	325.6	0.0	0.0	216.5	162.4	1,299.5	756.8
Total Study Area	2,918.4	2188.8	2,243.2	7,358.6	123.0	273.4	1,760.8	1,320.6	16,866.2	11,141.3

Source: Louisiana Department of Transportation and Development 1996.

* - Urban area estimates used.

5.8. VALUE OF PUBLIC RESOURCES - RAILROAD FACILITIES

The track values were calculated using the estimated track value per mile as determined from the Railroad Company assessments in the Biennial Report of the Louisiana Tax Commission. This value per mile was calculated using Main Mile Track Value divided by Main Miles as reported by railroad. These values were then multiplied by track miles identified in the study area.

Table 48. Estimated Track Values Using Depreciated Assessments.

Railroad Name	Division Name	Location/ Parish	Total Track Miles	Track Value per/mile ($)*	Real Estate Value per/mile ($)**
UP	NOLC1	Jefferson	8.7	12,000	1,170
UP	Alexandria4	Ascension/St. James/St. Charles	54.9	18,000	1,388
UP	Alexandria5	Assumption/Ascension	8.9	18,000	1,388
SP	Lafayette/Avondale2	Lafourche/St. Charles/Jefferson	30.7	3,000	2,379
SP	Lafayette/Avondale3	Terrebonne/Lafourche	13.8	3,000	2,379
SP	Lafayette/Avondale4	St. Mary/Terrebonne	51.5	3,000	2,379
NOPB	System2	Jefferson	8.2	5,000	799
NOLR	NOLC	Jefferson/Plaquemines	38.14	5,000	799
LDRR	Lafayette/Avondale NAPO	Assumption/Lafourche	15.2	200	354
LDRR	Lafayette/AvondaleH1	Lafourche/Terrebonne	2.1	200	354
Totals			232.14	67,400	13,389

* Using Main Mile Values as assessed by the Louisiana Tax Commission

** All values are depreciated values

Table 48. Estimated Track Values Using Depreciated Assessments. *(continued)*

Railroad Name	Division Name	Location/ Parish	All Other Property Value Per/Mile ($)**	Track Values Per/Mile ($)**	Total Estimated Value ($) **
UP	NOLC1	Jefferson	106	21,848	115,501
UP	Alexandria4	Ascension/St. James/St. Charles	2,813	38,395	1,218,835
UP	Alexandria5	Assumption/Ascension	2,813	38,395	197,589
SP	Lafayette/Avondale2	Lafourche/St. Charles/Jefferson	1,164	7,789	200,870
SP	Lafayette/Avondale3	Terrebonne/Lafourche	1,164	7,789	90,293
SP	Lafayette/Avondale4	St. Mary/Terrebonne	1,164	7,789	336,965
NOPB	System2	Jefferson	288	13,436	49,913
NOLR	NOLC	Jefferson/Plaquemines	288	13,436	232,158
LDRR	Lafayette/Avondale NAPO	Assumption/Lafourche	0	683	8,421
LDRR	Lafayette/AvondaleH1	Lafourche/Terrebonne	0	683	1,163
Totals			9,800	150,243	2,451,709

Source: Louisiana Tax Commission 1994.
* Using Main Mile Values as assessed by the Louisiana Tax Commission
** All values are depreciated values

5.9. VALUE OF PUBLIC RESOURCES - STRATEGIC PETROLEUM RESERVE

There is no known published value for the facilities located at the St. James Terminal described in Section 4.6.4 of this report. As with other public facilities, the assessment of value of the infrastructure is not available. This lack of assessment is common to public operations.

5.10. VALUE OF PUBLIC RESOURCES - AIRPORTS

Airports referred to in Section 4.6.5 of this report are a combination of public and private facilities. There are five public airports and 54 private airport/heliport facilities in the study area. The value of each of these facilities was not available per facility; however the private businesses were included in the assessment provided by the Louisiana Tax Commission for all commercial improvements.

5.11. VALUE OF PUBLIC RESOURCES - COMPLETED WETLANDS CONSERVATION PROJECTS

There are fourteen (14) completed wetlands conservation projects in six of the parishes within the study area (see Section 4.6.6). The total construction costs per parish are as follows: Jefferson Parish - $1.2 million; Lafourche Parish - $15,000; Plaquemines Parish - $11.2 million; St. Charles Parish - $175,000; St. Mary Parish - $7,500; and Terrebonne Parish - $4.9 million. The total construction cost for all projects was $16.7 million. These values are presented as reported and have not been recalculated to present day values. There is no known reconstruction value available for these facilities (Louisiana Department of Natural Resources, Coastal Restoration Division 1995B).

5.12. VALUE OF PUBLIC RESOURCES - FLOOD CONTROL, NAVIGATION AND HURRICANE PROTECTION PROJECTS

Table 49 is a tabulation of the documented construction costs presented in Section 4.6.7 of this report. These construction costs are from various years from 1916 through 1991. There is no known current reconstruction value for these facilities. As such, these values were not included in the Summary of Estimated Values.

Table 49. Project Costs and Estimates.

Projects	Parish	Year Completed	Cost ($)
Flood Control Projects:			
Harvey Canal-Bayou Barataria Levee	Jefferson	1974	1,000,000
Navigation Channels:			
Barataria Bay Waterway	Jefferson	1925, 1963, 1967	*204,400
Bayou Dupre		1939	*
Gulf Intracoastal Waterway	***	**	*113,000,000
Bayou Lafourche and Lafourche Jump Waterway	Lafourche	1941	524,024
Bayou Segnette		1948, 1951	*
Bayou Segnette Waterway		1957	374,000
Bayou Terrebonne		1916	120,089
Houma Navigation Canal	Terrebonne		*
Little Caillou Bayou		1929	77,761
Waterway from Empire to the Gulf of Mexico		1950	1,068,142
Waterway from the Intracoastal Waterway to Bayou Dulac		1938, 1964	*78,342
Hurricane Protection Projects:			
Grand Isle Hurricane Protection and Beach Erosion	Jefferson	1985, 1988, 1991	*33,100,000
Larose to Golden Meadow Hurricane Protection		NC	*114,000,000
New Orleans to Venice Hurricane Protection		NC	*240,000,000
Westwego to Harvey Canal Hurricane Protection	Jefferson	NC	*91,300,000
Total - All Projects			*594,846,758

Source: U.S. Army Corps of Engineers 1993.
* - Partial cost or cost not stated in Corps document.
** - Multiple years.
*** - Multiple parishes.
NC - Not completed.

5.13. VALUE OF PUBLIC RESOURCES - COASTAL RESTORATION PROJECTS PROPOSED

There are 21 projects proposed in the CWPPRA Priority Lists 1- 4 (Table 31). The total estimated construction cost of these facilities is \$64.2 million (1993\$). None of these projects has been completed at this time and, as such, were not included in the Summary of Estimated Values.

5.14. VALUE OF PUBLIC RESOURCES - PUBLIC WATER SUPPLY

Public water supply and facilities which provide water for drinking, commercial and agricultural use are invaluable to maintaining life in any area. As public facilities, generally, their infrastructure value is not determined. Over the years there were certainly construction costs compiled based on the original facilities and subsequent renovation costs as new standards for public water were introduced. However, there is no documented construction costs report and no known reconstruction value estimation available for presentation in this report.

5.15. VALUE OF PARKS AND RECREATIONAL FACILITIES

There are 362 park and recreational facilities in the study area. These facilities are housed on 66,602 ha (164,578 acres) of land (compiled from Appendix I). These facilities are federal state, parish, local government, commercial and non-profit owned and operated. There is no known source for the infrastructure value of these facilities. Although "travel value" methods are sometimes used to attribute a use value to such facilities, this was beyond the scope and resource constraints of this project.

5.16. VALUE OF ARCHEOLOGICAL SITES

There are 1,486 archeological sites in the eleven-parish study area as presented in Section 4.8 of this report. Each site is important from a historical/cultural/social context, but is extremely difficult to assign a dollar value. In the *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters* a section is presented regarding Archeological Site Protection. This report discusses potential site impacts, including direct oiling of archeological sites, human impacts such as unmonitored cleanup on or near sites, and unauthorized digging into archeological sites (Wooley and Haggarty 1995). There is considerable discussion regarding impact mitigation through constraints, including avoidance, access restrictions, and requirements that treatment take place in the presence of a monitor. No significant injuries were documented to these cultural resources by the Cultural Resource Program (CRP) during the extensive four- year cleanup. Government-sponsored damage assessment studies confirmed the effectiveness of the CRP site identification and protection approach (Wooley and Haggarty 1995). There was no valuation presented of the archeological sites themselves. The cost (value) attributed to the sites included clean-up costs and related protection activity costs only. Therefore, there being no established approach for ascribing value to archaeological sites in the study area, such a value is not included in the summary of estimated values.

5.17. SUMMARY OF ESTIMATED VALUES

The values computed in the previous tables have been adjusted to 1995 dollars using the annual average Consumer Price Indices for the years 1990, 1992, 1993 and 1995. These adjusted values have been compiled in Table 50 to quantify significant economic resources within the study area. Specifically, Residential Occupied and Residential Vacant were adjusted from 1990 to 1995 dollars; Commercial Structures, Oil and Gas, and Railroads were adjusted from 1993 to 1995 dollars; Farms - Land and Buildings were adjusted from 1992 to 1995 dollars; Schools and Highways/Roads/Bridges are 1995 estimated values and required no adjustment.

Table 50. Summary of Estimated Values.

Economic Resources	Estimated Values in $ Millions					
	Ascension	Assumption	Jefferson	Lafourche	Orleans	Plaquemines
Residential Occupied	1,337.66	388.21	4312.50	1,779.45	1,554.46	527.55
Residential Vacant	83.42	39.08	658.59	101.91	259.39	67.39
Commercial Structures	1500.11	209.67	6,195.59	430.68	6,101.68	1,027.88
Oil & Gas	30.63	47.76	82.56	250.16	0.00	481.66
Farms Land & Buildings	152.73	71.04	7.71	166.96	3.33	69.61
Schools	6.82	13.46	103.09	44.89	17.32	13.21
Highways/Roads/Bridges	579.30	259.40	2,205.90	739.80	5,051.10	198.90
Railroads						
Totals	3,690.67	1,028.62	13,565.96	3,513.84	12,987.28	2,386.21

Table 50. Summary of Estimated Values. *(continued)*

Economic Resources	Estimated Values in $ Millions					
	St. Charles	St. James	St. John	St. Mary	Terrebonne	Study Area
Residential Occupied	481.69	167.54	56.39	339.18	1,958.93	12,903.58
Residential Vacant	72.19	8.07	13.10	31.47	175.03	1,509.65
Commercial Structures	2,171.30	770.62	791.61	547.17	970.11	20,716.43
Oil & Gas	104.19	38.30	10.24	230.23	360.19	1,635.94
Farms Land & Buildings	28.79	78.32	23.46	123.29	55.83	781.06
Schools	24.56	6.46	2.27	11.08	58.94	302.10
Highways/Roads/Bridges	228.20	230.80	222.70	668.50	756.80	11,141.40
Railroads						2.60
Totals	3,110.91	1,300.12	1,119.78	1,950.93	4,335.84	48,992.75

Source: U.S. Department of Commerce 1992.
Source: Louisiana Tax Commission 1994.
Source: U. S. Department of Commerce 1994.
Source: Louisiana Department of Education 1991.
Source: Corne, Wayne, AIA 1996.
Source: Louisiana State Legislature. The Children First Act. No. 659. 1988.
Source: Louisiana Department of Transportation and Development 1996.
Source: Bureau of Labor Statistics 1996.

REFERENCES

Adams, R.D. (in press). Potential impact of used oil recycling in Louisiana's coastal fishing communities. Louisiana Oil Spill Coordinator's Office/Office of the Governor, Louisiana Applied Oil Spill Research and Development Program, Baton Rouge, Louisiana. 38pp.

Applied Technology Research Corporation. 1993. *Railroad Safety Information System Line Segment Maps*. Louisiana Department of Transportation and Development, Baton Rouge, LA.

Baker, J.M., L. Guzman, P.D. Bartlett, D.I. Little, and C.M. Wilson. 1993A. Long-term fate and effects of untreated thick oil deposits on salt marshes. Pages 395-400 In Proceedings; 1993 International Oil Spill Conference: Prevention, preparedness, response, March 29-April 1, 1993. United States Coast Guard, American Petroleum Institute and U.S. Environmental Protection Agency. American Petroleum Institute publication No. 4580.

Baker, J.M., D.I. Little, and E.H. Owens. 1993B. A review of experimental shoreline oil spills. Mendelssohn, I.A., M.W. Hester and J.M. Hill. 1993. Pages 583-590 In Proceedings; 1993 International Oil Spill Conference: Prevention, preparedness, response, March 29 - April 1, 1993. United States Coast Guard, American Petroleum Institute and U.S. Environmental Protection Agency. American Petroleum Institute publication No. 4580.

Baldwin, P.L. and M.F. Baldwin. 1975. *Onshore Planning For Offshore Oil - Lessons from Scotland.* The Conservation Foundation, Washington, D.C. 183. pp.

Bates, F.L., C.W. Fogleman, V.J. Parenton, R.H. Pittman, G.S. Tracy. 1963. *The Social and Psychological Consequences of a Natural Disaster: A Longitudinal Study of Hurricane Audrey*. Disaster Study Number 18. National Academy of Sciences, National Research Council, Washington D. C.

Boesch, D.F., M.N. Josselyn, A.J. Mehta, J.T. Morris, W.K. Nuttle, C.A. Simenstad, J.P. Swift. 1994. *Scientific Assessment of Coastal Wetland Loss,* Restoration and Management in Louisiana. *Journal of Coastal Research*, Special Issue No. 20, Baton Rouge, LA. 45. pp.

Bornholdt, M.A. and E.M. Lear. 1995. Outer continental shelf natural gas and oil resource management program: Cumulative effects 1987-1991. U.S. Department of the Interior. Minerals Management Service, Environmental Policy and Programs Division, Branch of Environmental Operations and Analysis. Herndon, Virginia, OCS Report MMS 95-0007.

Breaux, Eldon. 1995. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

Bureau of Labor Statistics. 1996. *Consumer Price Index - All Urban Consumers.* Series ID: cuur0000sa0. Base period: 1982-84=100.

Burger, J. 1994. *Before and after an oil spill: The Arthur Kill.* New Brunswick, New Jersey: Rutgers University Press. 305 pp.

Cahoon, D.R. (ed.) 1989. *Onshore Oil and Gas Activities Along the Northern Gulf of Mexico Coast: a Wetland Manager's Handbook.* Contract No. 68-04-6104, Work Assignment No. 1-01. Prepared for Lee Wilson and Associates, Inc. United States Environmental Protection Agency, Region 6, Dallas, TX. 154 pp.

Corne, Wayne. AIA 1996. Cost per square foot in conversation with Steve Gilbreath, T. Baker Smith and Son, Inc.

Davis, D.W. 1992. *Canals and the southern Louisiana landscape.* In *Geographical Snapshots of North American.* (D.G. Janelle, ed.) pp. 375-379. New York: The Guilford Press.

Davis, D.W. and J.L. Place. 1983. *The oil and gas industry of coastal Louisiana and its effect on land use and socioeconomic patterns.* Open file report 83-118. United States Department of the Interior, U.S. Geological Survey, Reston, VA. 73. pp. 73.

Day, J.W. and M. Diffley. 1993. *Testimony before the Panel on Scientific Principles of Coastal Wetland Loss, Restoration and Creation in Louisiana.* Baton Rouge, LA.

de la Cruz, A.A., C.T. Hackney, and B. Rajanna. 1981. Some effects of crude oil on a *Juncus* tidal marsh. *Journal of the Elisha Mitchell Society,* v. 97, pp. 14-28.

Delaune, R.D., W.H. Patrick, and R.J. Buresh. 1979. Effect of crude oil on a Louisiana *Spartine alterniflora* salt marsh. *Environmental Pollution,* v. 20, pp. 21-33.

Dunbar, J.B., L.D. Britsch, E.B. Kemp, III. 1992. *Land Loss Rates, Report 3, Louisiana Coastal Plain.* U.S. Army Engineer District, New Orleans, La.

Elstrott, Blain. 1995. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

Emmer, R.E., A. Rheams, and F. Wagner. 1992. *Offshore Petroleum Development and the Comprehensive Planning Process.* Contract No. 14-35-0001-30470. OCS Final Report submitted to U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional office, New Orleans, LA. Study MMS 92-0064. 76. pp.

Evangeline Economic and Planning District. 1994. *Hurricane Andrew, A Strategy for Economic Recovery.* Lafayette, LA.

Exxon Corporation. 1992. *Oil Spill Response Field Manual.* Exxon Production Research Company, New Jersey. 193. pp.

Francois, D.K. 1993. *Federal Offshore Statistics: 1992.* U.S. Department of the Interior, Minerals Management Service. OCS Report MMS 93-0066. U.S. Government Printing Office, Washington, D.C. pp. 155.

Franks, K.A. and P.F. Lambert. 1982. *Early Louisiana and Arkansas oil: a photographic history 1901-1946.* Texas A&M University Press, College Station, TX. pp. 241.

Fucik, K.W., K.A. Carr and B.J. Balcom. 1994. *Dispersed Oil Toxicity Tests With Biological Species Indigenous to the Gulf of Mexico.* OCS Study MMS 94-0021. Prepared by Continental Shelf Associates, Inc. for the U.S. Department of the Interior Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 97. pp and appendices.

Fuller, D.A., J.G. Gosselink, J. Barras, and C.E. Sasser. *(in press). Status and Trends in Vegetation and Habitat Modifications.* Reed, D.J. (Ed.) *Current Status and Historical Trends of Hydrologic Modification, Reduction in Sediment Availability and Habitat Loss/Modification in the Barataria and Terrebonne Estuarine System.* Baton Rouge, Louisiana, Barataria-Terrebonne National Estuary Program.

Gallaway, B.J. 1981. An ecosystem analysis of oil and gas development on the Louisiana continental shelf. U.S. Fish and Wildlife Service, Office of Biological Washington, D.C. FWS/)BS-81/27. 89 pp.

Gillman, K. 1977. *Oil and Gas in Coastal Lands and Waters.* U.S. Government Printing Office, Washington, D.C. 153. pp.

Gundlach, E.R., J.M. Neff, and D.I. Little. 1993. Evaluation of marine post-spill sties for long-term recovery studies. Washington, D.C.: Marine Spill Response Corporation. MSRC Technical Report Series 93-001. 176 pp.

Hampson, G.R. and E.T. Moul. 1978. No. 2 fuel oil spill in Bourne, Massachusetts: Immediate assessment of the effects of marine invertebrates and a three year study of growth and recovery of a salt marsh. *Journal of the Fisheries Research Board of Canada,* v. 35, pp. 731-744.

Hatchet, Kent. 1995. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

Henry, C.B., P.O. Roberts, E.B. Overton. 1993. *Characterization of Chronic Sources and Impacts of Tar Along the Louisiana Coast.* U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional, New Orleans, LA. pp. 64

Hershner, C. and J. Lake. 1980. Effects of chronic oil pollution on a salt marsh grass community. *Marine Biology,* v. 56, pp. 163-173.

Hoff, R.Z., G. Shigenaka, and CB. Henry, Jr. 1993. Salt marsh recovery from a crude oil spill: Vegetation, oil weathering, and response. Pages 307-311 In Proceedings; 1993 International Oil Spill Conference: Prevention, preparedness, response, March 29-April 1, 1993. United States Coast Guard, American Petroleum Institute and U.S. Environmental Protection Agency. American Petroleum Institute publication No. 4580.

Howe, Charles W. and Harold C Cochrane. 1993. *Guidelines For The Uniform Definition, Identification, and Measurement of Economic Damages From Natural Hazard Events.* University of Colorado, Institute of Behavioral Science, Boulder, CO.

Hymmel, Dale. 1995. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

Interagency Coordinating Committee on Oil Pollution Research. 1992. *Oil Pollution Research and Technology Plan.* U.S. Government Printing Office, Washington, D.C. 87. pp.

International Oil Scouts Association. 1994. *International Oil and Gas Development, Yearbook (Review of 1993), Volume 64, Production.* Mason Map Service, Inc., Austin, Texas. pp. 736-781.

Keller, B.D. and J.B.C. Jackson, eds. 1993. Long-term assessment of the oil spill at Bahia Las Minas, Panama, synthesis report, volume I: executive summary. OCS Study MMS 93-0047. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 129 pp.

Kucklick, J.H. (ed.). 1994. *Proceedings of the First Meeting of the Chemical Response to Oil Spills: Ecological Effects Forum.* Santa Cruz, California. August 9 - 10, 1994. MSRC. Technical Report Series 94-017. Marine Spill Response Corporation, Washington, D.C. 83. pp.

Lambert, Charles. 1995. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

Lambert, L. (ed). 1995. *The international oil spill control directory*, fifteenth edition. Arlington, MA.: Cutter Information Corporation. 264 pp.Landsea, Chris. 1993: *Atlantic Hurricane Tracking Data by Year*. Colorado State University. Boulder, Colorado.

Larson, D.K., D. Davis, R. Detro, P. Dumond, E. Liebow, R. Motschall, D. Sorensen, and W. Guidroz. 1980. *Mississippi Deltaic Plain Region Ecological Characterization: A Socioeconomic Study*. Vol. 1. Synthesis papers. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D. C. pp. 368.

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 1993. *Louisiana Coastal Restoration Plan, June 1993 Draft.* U.S. Army Corps of Engineers, New Orleans District. pp. 195.

Louisiana Department of Education. 1991. *Louisiana School Directory*. Bulletin 1462. Bureau of School Accountability. Baton Rouge, LA.

Louisiana Department of Natural Resources. 1995a. *Coastal Wetlands Planning, Protection, and Restoration Act, Summary of Priority Lists 1-4.* Coastal Restoration Division. Baton Rouge, LA.

Louisiana Department of Natural Resources. 1995b. *Summary of the Completed State Funded Coastal Wetlands Conservation and Restoration Projects.* Coastal Restoration Division...Baton Rouge, LA.

Louisiana Department of Natural Resources. 1995c. *Louisiana Energy Facts Annual 1994.* Technology Assessment Division. Baton Rouge, LA.

Louisiana Department of Transportation and Development 1984. *The Louisiana Water Resources Study Commission's Report to the 1984 Legislature.* Office of Public Works. Baton Rouge, LA.

Louisiana Department of Transportation and Development. 1994a. *Port Profiles.* Planning Division. Baton Rouge, LA.

Louisiana Department of Transportation and Development. 1994b. *Terrebonne and Lafourche Highway Maps.* Traffic and Planning Division, Baton Rouge, LA.

Louisiana Department of Transportation and Development. 1995. *Mileage by Parish.* Planning Division, Baton Rouge, LA.

Louisiana Department of Transportation and Development. 1996. *Cost Figures for Needs Study.* Road Design Section, Baton Rouge, LA.

Louisiana Department of Culture, Tourism and Recreation. 1996. *Site Files.* Division of Archeology. Baton Rouge, LA.

Louisiana Oil Spill Coordinator's Office. 1995. *Louisiana Oil Spill Prevention and Response Act.* Oil Spill Coordinator's Office, Office of the Governor, Baton Rouge, LA. 19 pp. and appendices.

Louisiana Oil Spill Coordinator's Office, personal communication, March 1, 1996.

Louisiana Tax Commission. 1994. *Twenty-Sixth Biennial Report 1992-1993.* Baker Printing Company, Baker, LA.

Marcke, Jovan. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

McKenzie, Lawrence S. III and Donald W. Davis. 1994. *Louisiana Gulf of Mexico Outer Continental Shelf Oil & Gas Activity Impacts.* Louisiana Mid-Continent Oil & Gas Association, Baton Rouge, LA. 118 pp.

Mendelssohn, I.A., M.W. Hester, and J.M. Hill. 1993. *Effects of Oil Spills on Coastal Wetlands and Their Recovery.* OCS Study MMS 93-0045. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region Office, New Orleans, LA. 46 pp.

Minerals Management Service, Gulf of Mexico OCS Region. 1995. Gulf of Mexico sales 157 and 161: Central and western planning areas, draft environmental impact statement. Volume 1, Sections I through IV.C. U.S. Department of the Interior. Minerals Management Service. New Orleans, LA., OCS EIS/EA MMS 95-0017. Van Horn, W., A. Melancon and J. Sun. 1988. Oil and gas program: Cumulative effects. U.S. Department of the Interior. Minerals Management Service. Herndon, Virginia, OCS Report MMS 88-0005.

Morgan, James P., Philip B. Larimore. 1957. *Changes in the Louisiana Shoreline.* Gulf Coast Association of Geological Societies. Baton Rouge, LA.

Natural Hazards Research and Applications Information Center. University of Colorado. 1992. *Floodplain Management In The United States: An Assessment Report, Volume 2: Full Report.* Federal Emergency Management Agency, Washington D. C.

OSRP News. 1996. Sacramento: California Department of Fish and Game, Office Oil Spill Prevention and Response. pp. 3.

Ritchie, W. and M. O'Sullivan (editors). 1994. The environmental impact of the wreck of the Braer. Edinburgh: The Scottish Office. 207 pp.

Skinner, S.K. and W.K. Reilly. 1990. *Oil Spill Contingency Planning - National Status.* The National Response Team, Washington, D.C. 112. pp.

Suhayda, Joseph and Mohamed Alawady. 1993. *Water Level Statistics for Design of Transportation Facilities in Coastal Louisiana.* Louisiana Transportation Research Center, Baton Rouge, LA.

T. Baker Smith & Son, Inc. 1996a. *Barrier Island Plan Phase 1 - Step C, Assessment of Resource Status and Trends.* Louisiana Department of Natural Resources, Baton Rouge, LA.

T. Baker Smith & Son, Inc.. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc.

Tabberer, D.K., W. Hagg, M. Coquat. 1985. *Pipeline impacts on wetlands. Final environmental assessment.* OCS EIS/EA MMS 85-0092. U.S Department of the Interior, Minerals Management Service, Metairie, LA. 41 pp.

Terrebonne Port Commission. 1985. *Assessment of Opportunities for Port Development Terrebonne Parish.* Port Waterways Institute, Louisiana State University.

Touchet, B. A.. 1995. Personal communication with. Baton Rouge, LA.

Townsend, Joe. Conversation with Steve Gilbreath, T. Baker Smith and Son, Inc. 1995.

University of New Orleans. 1993. *Louisiana Factbook.* New Orleans, LA.

U.S. Army Corps of Engineers. 1972. *History of Hurricane Occurrences Along the Gulf Coast.* New Orleans District, New Orleans, LA.

U.S. Army Corps of Engineers. 1975. *Hurricane Carmen 7-8 September 1974.* New Orleans District, New Orleans, LA.

U.S. Army Corps of Engineers, New Orleans District. 1987. *1985 Hurricanes: Juan, Danny, Elena.* New Orleans, LA.

U.S. Army Corps of Engineers. 1993. *Water Resources Development in Louisiana.* New Orleans District, New Orleans, LA.

U.S. Army Corps of Engineers. 1994. *Technical Data Report: Southeast Louisiana Hurricane Preparedness Study.* Federal Emergency Management Agency, Region VI. New Orleans District, New Orleans, LA.

U.S. Department of Commerce. 1991. *TIGER/Line Census Files, 1990.* CD ROM 57190. Bureau of the Census. Data User Services Division, Washington, D.C.

U.S. Department of Commerce. 1992a. *1990 Census of Population and Housing, Population and Housing.* Summary Tape File 3A, CD90-3A-25. Bureau of the Census. Data User Services Division, Washington, D. C.

U.S. Department of Commerce. 1992b. *County Business Patterns, 1990, Louisiana.* Bureau of the Census, Economics and Statistics Administration. U.S. Government Printing Office, Washington, D. C.

U.S. Department of Commerce. 1993. *Hurricane Andrew: South Florida and Louisiana August 23-26, 1992.* National Oceanic and Atmospheric Administration. National Weather Service, Silver Spring, MD.

U.S. Department of Commerce. 1993. *1990 Census of Population and Housing, Population and Housing, Population and Housing Unit Counts, Louisiana.* Bureau of the Census, Economics and Statistics Administration. U.S. Government Printing Office, Washington, D. C.

U.S. Department of Commerce. 1994. *1992 Census of Agriculture.* Part 18 Louisiana State and Parish Data. (AC92-A-18), Economic and Statistics Administration. Bureau of the Census, Washington, D. C.

U.S. Department of Commerce. 1996. *Part 11, National Ocean and Atmospheric Administration, 15 CFR Part 990, Natural Resource Damage Assessments: Final Rule.* Federal Register, vol. 61, No. 4, Friday, January 5, 1996. pp. 440-510.

U.S. Department of Energy. 1988. *St. James Terminal.* Pamphlet No. DOE/FE-0111-7, Assistant Secretary for Fossil Energy, Washington, D.C.

U.S. Department of the Interior. 1989. *Visual No. 1 Historic Leasing and Infrastructure.* Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA.

U.S. Department of the Interior. 1993. *Natural Resource Damage Assessment and Restoration Processes.* National Performance Review Laboratory. Office of Environmental Affairs, Washington, D.C. 55 pp.

U.S. Department of the Interior. 1995. *Water Use in Louisiana, 1994.* United States Geological Survey, Baton Rouge LA.

Van Horn, W., A. Melancon and J. Sun. 1988. Oil and gas program: Cumulative effects.U.S. Department of the Interior. Minerals Management Service. Herndon, Virginia, OCS Report MMS 88-0005.

Von Zharen, W.M. 1994. *Risk Evaluation of Ship-to-Ship Oil Transfer. An Assessment of Lightening as a Predictably Sound Environmental Risk: Inherent Relative Concerns and Operational Safeguards.* Maritime and Environmental Management and Research, Inc., Washington, D.C. 57. pp.

Wicker, K.M., R.E. Emmer, Dave Roberts, and J. van Beek. 1989a. *Pipelines, Navigation Channels, and Facilities in Sensitive Coastal Habitats, An Analysis of Outer Continental Shelf Impacts, Coastal Gulf of Mexico. Volume I: Technical Narrative.* OCS Report/MMS 89-0051. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. 470 pp.

Wicker, K.M., R.E. Emmer, D. Roberts, and J. van Beek. 1989b. *Pipelines, navigation channels, and facilities in sensitive coastal habitats, an analysis of outer continental shelf impacts, coastal Gulf of Mexico. Volume 2: Atlas of Physical, Cultural, and Biological Parameters.* OCS Report MMS 89-0052. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. 83 pp.

Williams, S.J., S. Penland, A.H. Sallenger, Jr. 1992. *Atlas of Shoreline Changes in Louisiana From 1853 to 1989.* United States Department of the Interior, U.S. Geological Survey, Reston, VA.

Wooley, C.B. and J.C. Haggarty. 1995. *Archeological Site Protection: An Integral Component of the Exxon Valdez Shoreline Cleanup.* Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219. Peter G. Wells, James N. Butler, and Jane S. Hughes, Eds. American Society for Testing and Materials, Philadelphia, PA. pp. 933 - 949.

APPENDIX M
SELECTED ECONOMIC RESOURCES SUSCEPTIBLE TO LOSS FROM STORM SURGE

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Jefferson Parish

Tract #	Block Group	Miles Roads	Miles Highways	Miles R/R	Occupied Housing	$	Vacant Housing	$
027701	9	0.29	0.00	0.00	0	0	0	0
027702	3	5.75	0.00	0.00	447	26,283,600	15	862,500
027702	5	7.80	0.00	0.00	251	11,194,600	0	0
027702	9	7.10	0.00	0.00	68	6,494,000	20	1,150,000
0279	1	15.07	0.00	0.00	561	31,752,600	78	4,485,000
0279	2	11.60	0.00	0.00	392	25,676,000	85	4,887,500
0279	3	7.40	0.00	0.00	449	21,552,000	80	4,600,000
0279	4	22.54	0.00	0.00	222	9,812,400	404	23,230,000
0279	5	11.75	0.00	0.00	226	8,927,000	782	44,965,000
0279	6	8.94	0.00	0.00	93	4,780,200	273	15,697,500
0279	9	0.00	0.00	0.00	0	0	0	0
027999	4	0.00	0.00	0.00	0	0	0	0
TOTALS		98.24	0.00	0.00	2,709	146,472,400	1,737	99,877,500

Road estimated reconstruction cost = 98.24 miles * $750,000/mile = $73,680,000.

Source: Louisiana Tax Commission 1994.
Source: U.S. Department of Commerce 1992 (a
Source: U.S. Department of Commerce 1991.
Source: Louisiana Department of Transportation and Development 1996.

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Lafourche Parish.

Tract #	Block Group	Miles Roads	Miles Highways	Miles R/R	Occupied Housing	$	Vacant Housing	$
0211	5	34.07	13.48	0.00	403	10,881,000	144	5,025,600
0212	2	13.96	9.91	0.38	577	24,060,900	87	3,036,300
0213	2	10.68	1.74	0.00	448	18,009,600	56	1,954,400
0216	1	43.09	3.21	0.00	885	42,657,000	59	2,059,100
0216	2	23.85	7.96	0.00	148	10,582,000	0	0
0216	5	17.25	12.98	0.00	334	17,201,000	22	767,800
0219	3	19.85	6.79	0.00	354	21,735,600	24	837,600
TOTALS		162.75	56.07	0.38	1,721	145,127,100	105	13,680,800

Road estimated reconstruction cost = 162.75 * $750,000/mile = $122,062,500.
Highway estimated reconstruction cost = 56.07 * $750,000/mile = $42,052,500.

Source: Louisiana Tax Commission 1994.
Source: U.S. Department of Commerce 1992 (a).
Source: U.S. Department of Commerce 1991.
Source: Louisiana Department of Transportation and Development 1996.

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Plaquemines Parish.

Tract #	Block Group	Miles Roads	Miles Highways	Miles R/R	Occupied Housing	$	Vacant Housing	$
0504	1	85.72	8.85	19.68	299	12,049,700	279	14,535,900
0504	2	18.93	2.06	6.48	343	29,017,800	27	1,406,700
0504	3	7.31	0.88	2.65	173	8,217,500	8	416,800
0505	1	6.71	2.16	1.92	253	12,042,800	25	1,302,500
0505	2	14.40	2.75	2.77	351	19,515,600	52	2,709,200
0505	3	10.44	2.93	3.24	309	13,596,000	46	2,396,600
050599	3	0.00	0.00	0.00	0	0	0	0
0506	1	25.19	6.11	5.72	565	29,832,000	74	3,855,400
0506	2	16.11	3.19	1.52	338	10,173,800	45	2,344,500
0506	3	3.05	0.00	0.00	0	0	0	0
0507	1	12.61	1.84	0.00	328	10,922,400	84	4,376,400
0507	2	12.84	1.41	0.00	338	18,759,000	55	2,865,500
0507	3	17.34	4.20	0.00	299	12,707,500	58	3,021,800
0507	4	6.81	1.33	0.00	282	10,180,200	37	1,927,700
0508	1	18.41	0.00	0.00	27	1,485,000	6	312,600
0508	2	17.75	4.30	0.00	493	25,685,300	88	4,584,800
0508	3	16.14	3.68	0.00	333	25,807,500	46	2,396,600
TOTALS		289.76	45.69	43.98	4,731	239,992,100	930	48,453,000

Road estimated reconstruction cost = 289.76 miles * $750,000/mile = $217,320,000.
Highway estimated reconstruction cost = 45.69 miles * $750,000/mile = $34,267,500.
Track value = $5,000/mile.

Source: Louisiana Tax Commission. 1994.
Source: U.S. Department of Commerce. 1992 (a).
Source: U.S. Department of Commerce. 1991.
Source: Louisiana Department of Transportation and Development 1996.

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Terrebonne Parish.

	Block	Miles			Occupied		Vacant	
Tract #	Group	Roads	Highways	R/R	Housing	$	Housing	$
0006	3	5.87	0.00	0.00	482	13496000	35	1,463,000
0006	4	5.83	0.00	0.00	217	8094100	15	627,000
0006	5	6.46	0.00	0.00	391	23381800	23	961,400
0006	6	2.79	0.00	0.00	334	18303200	27	1,128,600
0007	1	8.54	0.00	0.00	623	24483900	38	1,588,400
0007	2	6.41	0.00	0.00	386	14397800	37	1,546,600
0007	3	5.85	0.00	0.00	552	19982400	45	1,881,000
0007	4	5.03	0.00	0.00	473	15561700	52	2,173,600
0007	5	12.86	0.00	0.97	154	12243000	4	167,200
0008	1	7.52	0.00	0.49	377	17342000	29	1,212,200
0008	2	5.02	0.00	0.02	477	22896000	17	710,600
0008	3	8.83	0.00	0.00	686	37730000	50	2,090,000
0008	4	5.54	0.00	0.00	426	20405400	21	877,800
0008	5	4.00	0.00	0.35	246	16998600	13	543,400
0008	6	5.81	0.00	0.76	170	7633000	0	0
0009	5	9.09	1.28	0.01	324	22420800	8	334,400
0010	1	20.21	3.09	0.00	536	36072800	42	1,755,600
0010	2	13.07	4.69	0.00	381	18745200	30	1,254,000
0010	3	12.21	0.00	0.00	664	59029600	20	836,000
0011	1	9.12	1.61	0.00	213	13291200	9	376,200
0011	2	12.47	4.55	0.00	482	18412400	47	1,964,600
0011	3	27.82	0.00	0.00	328	10889600	133	5,559,400
0011	4	8.88	3.14	0.00	148	2219852	108	4,514,400
0012	1	17.29	5.68	0.00	521	26883600	24	1,003,200
0012	2	10.08	0.02	0.00	394	15287200	29	1,212,200
0012	3	8.19	0.34	0.00	366	22655400	20	836,000
0012	4	6.46	2.45	0.00	454	22109800	17	710,600
0012	5	7.29	4.89	0.00	635	20193000	67	2,800,600
0012	6	12.57	15.18	0.00	164	4723200	572	23,909,600
001222	6	0.00	0.00	0.00	0	0	0	0
0013	1	38.14	1.48	4.55	242	11833800	15	627,000
0013	2	15.02	0.00	0.00	453	12276300	44	1,839,200
0013	3	6.35	8.21	0.00	646	25323200	63	2,633,400
0013	4	13.17	3.29	0.00	173	2594827	189	7,900,200
0014	1	17.29	0.00	0.00	467	19894200	36	1,504,800
0014	2	24.13	0.00	0.00	209	12393700	21	877,800
0014	3	14.07	0.00	0.00	222	14985000	37	1,546,600
0014	4	24.41	0.00	0.00	299	8222500	39	1,630,200
001598	1	6.75	0.00	0.00	135	10435500	31	1,295,800
001598	3	9.39	3.11	0.00	387	25658100	9	376,200
001598	4	23.58	5.60	0.00	239	15678400	23	961,400

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Terrebonne Parish. *(continued)*

Tract #	Block Group	Miles: Roads	Miles: Highways	Miles: R/R	Occupied Housing	$	Vacant Housing	$
0016	1	11.51	5.01	4.98	215	7890500	15	627,000
0016	2	26.86	9.20	5.36	367	16588400	61	2,549,800
0016	3	28.06	7.49	0.00	517	29262200	47	1,964,600
TOTALS		529.84	90.31	17.49	16,175	778,919,179	2,162	90,371,600

Road estimated reconstruction cost = 529.84 miles * $750,000/mile = $397,389,000.
Highway estimated reconstruction cost = 90.31 miles * $750,000/mile = $67,732,500.
Track value = $3,000/mile.

Source: Louisiana Tax Commission. 1994.
Source: U.S. Department of Commerce. 1992 (a).
Source: U.S. Department of Commerce. 1991.
Source: Louisiana Department of Transportation and Development 1996.

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Schools.

School Name	Parish	Total Pupils	Sq. Feet @ 35 sf./Pupil	Est. Construction Cost @ $80/sf. ($)
Fisher Middle/High School	Jefferson	520	18,200	1,456,000
Grand Isle High School	Jefferson	330	11,550	924,000
Jean Lafitte Elem. School	Jefferson	624	21,840	1,747,200
subtotal		1,474	51,590	4,127,200
Bayou Boeuf Elem. School	Lafourche	194	6,790	543,200
subtotal		194	6,790	543,200
Boothville-Venice School	Plaquemines	696	24,360	1,948,800
Buras High School	Plaquemines	1,009	35,315	2,825,200
Buras Middle School	Plaquemines	354	12,390	991,200
Port Sulphur High School	Plaquemines	798	27,930	2,234,400
subtotal		2,857	99,995	7,999,600
Boudreaux Canal School	Terrebonne	168	5,880	470,400
Bourg Elem. School	Terrebonne	400	14,000	1,120,000
Dularge Elem. School	Terrebonne	338	11,830	946,400
Gibson School	Terrebonne	255	8,925	714,000
Greenwood Middle School	Terrebonne	235	8,225	658,000
Lacache Middle School	Terrebonne	510	17,850	1,428,000
Little Caillou Elem. School	Terrebonne	120	4,200	336,000
Montegut Elem. School	Terrebonne	202	7,070	565,600
Montegut Middle School	Terrebonne	714	24,990	1,999,200
Pointe-Aux-Chenes Elem. School	Terrebonne	259	9,065	725,200
South Terrebonne High School	Terrebonne	1,050	36,750	2,940,000
Upper Little Caillou School	Terrebonne	600	21,000	1,680,000
subtotal		4,851	169,785	13,582,800
Total All Schools		9,376	328,160	26,252,800

Source: Louisiana Department of Education 1991.

Source: Corne, Wayne, AIA 1996.

Source: Louisiana State Legislature. The Children First Act. No. 659. 1988.

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Oil and Gas Wells.

Parish	Field Names	Date of Discovery	Number of Wells
Jefferson	Barataria	1939	49
	Barataria South	1947	15
	Barataria West	1947	44
	Bassa Bassa Bay	1941	1
	Bay de Chene	1941	194
	Bayou de Fleur	1946	33
	Bayou de Fleur South	1979	1
	Bayou Perot	1945	22
	Bayou Villars	1955	26
	Lafitte	1936	479
	Lake Salvador NE	1958	1
	Little Lake	1948	122
	Little Lake South	1956	4
	Manila Village	1949	71
	Queen Bess Island	1946	31
	Three Bayou Bay	1956	26
Jefferson subtotal			1119
Lafourche	Bay Courant	1974	2
	Bay Jaque	1958	18
	Bay Marchand Block. 2 Onshore	n/d	9
	Bayou Boeuf	1968	3
	Bayou Boeuf South	1973	27
	Bayou Chevreuil	1959	7
	Bayou des Allemands	1937	129
	Bayou Ferblanc	1959	28
	Bully Camp	1942	173
	Clovelly	1951	75
	Coffe Bay	1953	26
	Delta Farms	1940	191
	Delta Farms West	1952	19
	Fishermans Bay	1967	1
	Gheens	n/d	1
	Golden Meadow	1938	818
	Golden Meadow East	1951	17
	Grandbois	1982	12
	Joe McHugh	1975	2
	Larose Northeast	1956	1
	Lake Enfarmer	1955	30
	Lake Long	1937	45
	Lake Raccourci	1949	91
	Leeville	1931	445
	Leeville NE	1983	1
	Little Temple	1946	36
	Plum Point	1960	5
	Point Chicot	1960	2
	Raccoon Lake	1974	3

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Oil and Gas Wells. *(continued)*

Parish	Field Names	Date of Discovery	Number of Wells
	Raceland	1936	78
	Timbalier Bay Onshore	1939	590
Lafourche subtotal			2885
Plaquemines	Alliance	1946	8
	Bastian Bay	1941	161
	Buras	1959	11
	Diamond	1958	22
	Drakes Bay	1982	9
	Happy Jack	1973	2
	Lake Hermitage	1934	38
	Lake Washington	1931	583
	Magnolia	1952	13
	Manila Village SE	1985	10
	Nairn	1958	3
	Potash	1937	93
	Saturday Island	1957	49
	Saturday Island SE	1983	7
	Saturday Island West	1989	1
	Venice	1937	283
Plaquemines subtotal			1293
Terrebonne	Bay Baptiste	1938	19
	Bay Junop	1948	22
	Bay Round	1958	1
	Bay St. Elaine	1957	428
	Bay Wallace	1974	1
	Bayou Copasaw	1971	4
	Bayou Copasaw S	1972	2
	Bayou du Large	1972	5
	Bayou Jean LaCroix	1951	32
	Bayou Penchant	1944	67
	Bayou Pointe Au Chien	1969	1
	Bayou Rambio	1955	11
	Bayou Sauveur	1972	6
	Bourg	1952	48
	Bourg South	1957	5
	Bourg Southwest	1961	5
	Caillou Island	1930	1,248
	Chauvin	1957	12
	Chauvin South	1960	19
	Deer Island	1942	54
	Deer Island West	1958	3
	Delarge	1938	11
	Dog Lake	1929	284
	Donner	1958	13
	Donner East	1971	1

Appendix M. Economic Resources Susceptible to Loss from Storm Surge. Oil and Gas Wells. *(continued)*

Parish	Field Names	Date of Discovery	Number of Wells
	Four Isle Dome	1935	76
	Four League Bay	1952	11
	Gibson	1937	116
	Gibson East	1943	6
	Gibson Northeast	1941	36
	Halter Island	1953	21
	Houma North	1947	1
	Houma South	1938	11
	Humphreys	1956	17
	Isles Dernieres	1957	1
	Kent Bayou	1950	28
	Kent Bayou North	1966	2
	Lake Barre	1929	512
	Lake Boudreaux	1971	6
	Lake De Cade	1942	16
	Lake De Cade East	1965	9
	Lake De Cade South	1967	1
	Lake Gero	1970	17
	Lake Hatch	1948	102
	Lake Pelto	1929	323
	Lapeyrouse	1941	76
	Lirette	1937	73
	Montegut	1957	24
	Montegut North	1973	5
	Montegut Northeast	n/d	3
	Mosquito Bay	1955	6
	Mosquito Bayou	1974	1
	Orange Grove	1953	32
	Palmetto Bayou	1955	6
	Pass des Ilettes	1955	4
	Pass Wilson	1958	7
	Pelican Lake	1957	3
	Point Au Fer	1941	50
	Salt Bay	1958	2
	Seabreeze Pass	1968	1
	St. Paul Bayou	1962	9
	Sunrise	1957	23
	Sunrise South	1960	5
	Turtle Bayou	1949	37
	Turtle Bayou North	1957	10
	Wildcat Bayou	1957	2
Terrebonne subtotal			3,993

Source: International Oil Scouts Association 1994. International Oil and Gas Development, Yearbook (Review of 1993), Volume 64, Production. Austin, Texas: Mason Map Service, Inc. pp. 736-781

Source: Louisiana Tax Commission. 1994. Twenty-Sixth Biennial Report 1992-1993. Baker Printing Company. Baker, LA. (Well values per parish per well: Jefferson - $34,268; Lafourche - $64,923; Plaquemines - $47,856; Terrebonne - $51,056.